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A Supplement to the Fauna and Flora of Horn Island, Mississippi

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**A Supplement to the
Fauna and Flora of Horn Island,
Mississippi**

by

E. Avery Richmond

Gulf Coast Research Laboratory

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Figure 1. *Panicum amarum* Elliott — Bitter Grass



Figure 2. *Uniola paniculata* Linnaeus — Sea Oats



Figure 3. From Sound (Section 18)



Figure 4. Looking West from Section 24

I. INTRODUCTION

Since the publication of "The Fauna and Flora of Horn Island, Mississippi" (Richmond 1962) search for unrecorded species present on this island, or in the waters surrounding it, has been continuing by myself and others. The premise that all of the plants and animals living in a given area can never be located completely is naturally well-founded. However, it seems advisable to continue the search for unlisted species of Horn Island.

Many unrecorded specimens have been collected and it seems proper at this time to make a supplementary list available to the public, particularly those interested in fields of science and nature. Knowing what is present on the island doubtless will tend to stimulate biological studies in various fields of endeavor.

The card catalogues of the Gulf Coast Research Laboratory Museum have been carefully examined by me through the courtesy of Mr. C. E. Dawson, Curator. Dr. Gordon Gunter kindly made some of his unpublished data of 1956 and 1957 available. Many visits to Horn Island have been made by the writer and others. In fact all members or students from the Laboratory have contributed in some way or other and, when known, credit is given to each one. The new contributors since the issue of my 1962 paper include W. I. Anderson, recently deceased, of the Shearwater Pottery Company. His expert knowledge of bird life has been especially helpful. David Peterson, manager of the Gulf Island National Wildlife Refuges since he replaced John H. Walther, K. E. Myers and Jerry E. Blackard, respectively managers of previous years, has been extremely cooperative. Frank Carroll, who has been associated with these managers, has assisted me materially. Marvin Phillips, formerly with the United States Army and stationed on the island, accompanied me on many trips during 1944 and 1945.

As usual, the facilities of Cornell University, the Academy of Natural Sciences of Philadelphia, the United States National Museum and the American Museum of Natural History have been available to me for identification. W. J. Gertsch of the American Museum identified the spiders. T. E. Bowman (United States National Museum), has checked a number of crustaceans as has Douglas Farrell of the Gulf Coast Research Laboratory. R. B. Channell (Vanderbilt University), Roland M. Harper (Alabama University) recently deceased, and E. T. Wherry (University of Pennsylvania) verified the names of many plants. Dr. Harper reports that *Pinus clausa* (Engelm.) Vasey, the spruce-pine of Florida, although present in Alabama, is otherwise restricted to Florida. A single specimen is growing on Horn Island according to Dr. Channell and is listed in my original paper (1962). Dr. Harper stated in 1928 that *Pinus clausa* is confined to the stationary dunes of pure white sand on the coast of Baldwin County, Alabama. There is no doubt that many of the plants originally established on Horn Island have disappeared and also that many others are constantly getting a foothold there. For instance, the cypress has gone and the chinaberry tree has arrived.

Again credit is extended to the specialists who kindly gave their time to verify or name the species contained in the lists given in

Chapter IV. My 1962 paper thanked many too briefly but I will not repeat the entire list. Many additional specialists have been interviewed and their courtesy is appreciated. Included are the following scientists: W. A. Connell, D. R. Davis, R. C. Froeschner, J. L. Herring, R. W. Hodges, J. M. Kingsolver, T. J. Spilman and Richard E. White of the United States National Museum; M. D. Leonard, retired, formerly with the Shell Oil Company; Miss E. Van Tassell (formerly at Catholic University, Washington, D. C.); Robert C. Graves (Bowling Green State University, Ohio) and L. L. Pechuman (Insect Curator, Cornell University).

Henry Yost, deceased, and J. Cowger of the Pest Control Laboratory, United States Department of Agriculture, at Gulfport, Mississippi, gave me some supplies and valuable suggestions. My retired friend, Henry Dietrich, former Curator of Entomology at Cornell University, identified many beetles, especially carabids. James E. Böhlke checked my determinations of a number of fresh water fishes. Leona W. Richmond typed most of my preliminary notes and took some very excellent photographs in connection with this study.

James S. Franks of the University of Mississippi and the Gulf Coast Research Laboratory has collected the fishes of the lagoons and ponds of Horn Island through the courtesy of the Fish and Wildlife Service of the U. S. Department of the Interior. He was aided financially by a modest N. S. F. grant obtained by the Gulf Coast Research Laboratory. A number of species, recently collected by him, have been added to my original list.

Dr. A. E. Schuyler helped particularly in the accurate determination of the sedges. H. W. Wilkens of Reading, Pennsylvania, called my attention to several plants not previously listed. Wilkens, visiting the Gulf Coast Research Laboratory in the spring and fall of 1965, did some collecting on the mainland but did not go to Horn Island. He reports that Richard L. Diener, formerly of Keesler Air Force Base, collected fifteen specimens on the island. Some of his specimens were not previously listed. E. P. Bicknell (1899) and E. E. Sherff (1933) each described a new species of plant from Horn Island. The species were collected by S. M. Tracy. As yet, I have not located *Coreopsis corninsularis* Sherff.

II. DESCRIPTION OF THE ISLAND

Horn Island is briefly described by Richmond (1962). As is well known, its conformity is constantly changing. This is particularly noticeable along the shoreline and from the changes in the shape and size of the lagoons and ponds. Evidently the southeastern portion is losing its foundation to the Gulf, whereas the northwestern area is gradually building up. This is in keeping with Richard R. Priddy's (1965) premise that the changes are due to the Mississippi River's power to move the barrier islands by "long shore" currents. These currents discharge southeastward and are diverted northward towards the islands and then westward. The result, he states, is that the islands are moving westward and to some extent southward.

The strong root system of the slash pine holds the central region (East and West) more or less in a stable equilibrium. Wax myrtle, yaupon, groundsel, rosemary, bitter beachgrass (Fig. 1) and sea oats (Fig. 2) doubtless have helped materially.

The dunes on the south side took a terrific beating in the fall of 1965. An attempt had been made by the Fish and Wildlife Service management to anchor those areas by bulldozing the sand into seemingly protective dunes. It was hoped that such a method, together with the use of winter fences (Fig. 5) would tend to alleviate the onslaught of the wind and Gulf waters. No real success was attained and the southern shore area was definitely flattened (Fig. 6). Most of the higher natural dunes held fast. LaGorce (1915) writes most interestingly about the ravages created by the Atlantic Ocean on our eastern coast.

During the passage of hurricane Betsy, heavy rains fell on lower Mississippi from the ninth to twelfth of September 1965. This rain, coupled with winds varying from 70 to 90 miles per hour, caused much shifting of the sands and the recently constructed dunes were leveled off. Raccoons, deer and other animals from all the islands were drowned and a number were washed up on the shore of the mainland. Much miscellaneous debris was dumped on the island. Tropical sea-bean seeds and a ten-foot palm tree bole were found near the area of the former army barracks.

The late W. I. Anderson, who was a well-known naturalist, artist and one of the owners of the Shearwater Pottery of Ocean Springs, attained one of his lifelong ambitions when he weathered this hurricane. He was wont to frequent the island for weeks at a time, as he communed in solitude with nature. Many ideas, emanating from his observations, were used in his pottery designs. At the time that Betsy was on a rampage, he was camping on his favorite so-called abode. When the water rose to his armpits, he tied the painter of his small boat about his waist and moved away from the rising waters to a higher level on one of the larger dunes. Darkness fell and he spent the night and following day safely in the leeward of the higher dunes until the storm abated. He saw his favorite pig washed away and drowned.

On 10 July 1966, an exhibition of some of Anderson's paintings of Horn Island scenes, plants and animals was staged at a motel in Pascagoula, Mississippi.

The tropical storm Debbie left a record of 16.85 inches of rainfall in downtown Mobile on September 29th and 30th of 1965. I have no information of its effect on Horn Island.

III. HISTORICAL DATA

Although Claiborne (1880) did not write about Horn Island, he did write quite extensively concerning Dauphin Island and Ship Island, which lie very close to Horn. Unfortunately his Volume II was destroyed by fire.

Guyton (1952) in a school textbook entitled "Our Mississippi" tells about Pierre LeMoyne d'Iberville's journey from France via Santo Domingo to Ship Island. On February 10, 1699, the expedition arrived. There, they were met by friendly Biloxi Indians. The Biloxis informed d'Iberville relative to a "near-by" mainland and especially about a large river to the west. Leaving his fleet anchored, he and his younger brother, Bienville, toured the coast and located the Mississippi River. Later they returned to Ship Island and at Old Biloxi (Ocean Springs) built Fort Maurepas on April 8, 1699. My previous paper (1962) states that Indians stayed "close to the mainland." Such is evidently incorrect in view of the presence of the Biloxis on Ship. Since the Gulf islands were separated only by relatively narrow expanses of water, it seems very likely that the Indians did roam on Horn. However, no evidence has been revealed concerning such peregrinations. As Thompson (1964) stated, "Horn Island is a blurred page in history." In 1965 Thompson again wrote about Horn Island and used some illustrations. The lighthouse, which was washed away in 1906, was pictured. Another unmanned lighthouse was erected on the north side of Petit Bois. The Pascagoula and Moss Point Chronicle (1965) published an interesting article about these lighthouses.

Since 1945, all military buildings noted in my first paper have been removed or destroyed by the weather elements. Only the power-house chimney in the operations area remains standing. In 1963 the Fish and Wildlife Service erected a 20 x 40 feet crew cabin on Horn Island near the area where the former headquarters of the military establishment was located during World War II. This cabin was erected six feet above a concrete flooring which supports the beams of the building. In 1965, a garage with a storeroom was built to house the vehicles and to supply extra storage space.

Transportation to and from the Island was made available by the Gulf Coast Research Laboratory or the Fish and Wildlife Service. The Laboratory trawler, HERMES, and the 30-foot SKIMMER of the Wildlife Service were used. Travel on the island was made on foot or by a Refugees jeep.

IV. ANIMAL AND PLANT LISTS

"There is not a property in nature but a mind is born to seek and find it, for it is not the plants or the animals, innumerable as they are, nor the whole magazine of material nature that give the sum power, but the infinite applicability

of these things in the hands of thinking man, every new application being equivalent to a new material."

—R. W. Emerson (1879) 1891

As in my 1962 paper, the species listed include only those animals and plants which were actually collected or sighted on Horn Island or in the waters around it out to a few fathoms of depth. The listings herein include only the records acquired from 1962 to 1966 inclusive.

A black-light trap was used occasionally instead of a New Jersey light trap for taking insects. However, its use did not prove entirely satisfactory. Hand-nets, pans, picking up and cupping proved more successful. In 1963, Kent Meyer ran the trap for several days during early April and two lots of collections were forwarded to me. An immediate kill was not obtained and most of the more delicate insects were ruined beyond identification. Cyanide was used as the killing agent. One other collection was made by Jerry Blackard on 14 April 1965. Ethyl acetate was used as the killing agent and the results proved more successful. Due to various climatic and labor difficulties, no further runs were made until June 1966. Now the use of 70% isopropyl alcohol and ethyl acetate keeps the collection in better shape.

The observance of a Barn Owl and the Coypu (Nutria) on the island in 1966 was called to my attention by David Peterson, J. S. Franks and others. Tracks of the River Otter were reported by Boyd Kynard and the otter is apparently quite common although I do not list it. Just when these animals moved in is not known. W. I. Anderson saw animals on drifting logs, boxes, etc. from time to time. Bond (1966) briefly discusses the transportation of small animals, invertebrates and birds by vegetative rafts on ocean waters. Hogs raised on the island before 1940 are still present. Trapping has reduced them somewhat.

Ruby-throated hummingbirds migrated through the Island in the Spring of 1964. They were very numerous and for a number of days fed quite commonly on purple thistle. In 1965, I arrived at the island very early in hopes of seeing their activity but no such migration occurred. None were reported in 1966. The nests of the Brown Pelicans on the North Islands were seriously depleted by adverse weather conditions in 1960 but lately the species appears to be on the increase. Several flocks were observed in 1966 and a colony of more than one hundred were seen using a group of spoil bank islands in the Sound just south of Pascagoula. However, their present nesting place is unknown.

A number of recently collected plants have been given to the Academy of Sciences in Philadelphia, as well as to the Bailey Hortorium of Ithaca, New York.

Aside from standard books and texts, publications by the following authors and institutions have been helpful in the studies of the animals and plants encountered in the Southern Mississippi area—Jenkins (1933), Behre (1950), Radford, Ahles and Bell (1964), Ralph Smith *et al.* (1964), Taylor (1960) and Williams (1964). Attention should be called to Richard Lane's (1957) excellent presentation of the history and activities of the Gulf Coast Research Laboratory.

No concentrated effort has been made to consider the protozoans, algae, mosses or ferns but some algae and ferns are listed. Humm and Caylor (1957) wrote extensively on the "Summer Marine Flora of Mississippi Sound" but nothing was specifically collected near Horn Island. F. Drouet of the Academy of Natural Sciences of Philadelphia identified several species of algae.

R. B. Channell's manuscript on "Vegetation of the West End of Horn Island" was most interesting and helpful to me and to members of the teaching staff at the Laboratory. He has also collected many species of algae on trips to Horn Island with his classes during recent years and has kindly given me their names. These species are listed.

Pictures in this paper will perhaps give the reader a broader vision of the plants and characteristic scenes encountered on Horn Island (Figs. 1-12).

An examination of Table No. 1 shows 1,568 species of plants and animals collected and identified from 1944 through 1966, 468 species since 1961. Naturally the insects predominate in numbers (712 species). The fishes follow with 156 species. Two hundred four species of plants are recorded.

TABLE 1
Number of Identified Members of the Fauna and Flora
Horn Island Records (1944-1966)

| ANIMAL PHYLA AND MAJOR SUBDIVISIONS | FAMILIES | GENERA | SPECIES |
|--|----------|--------|---------|
| Lower Invertebrates (through Annelida) | 28 | 30 | 30 |
| Mollusca | 56 | 88 | 110 |
| Arthropoda (Classes) | | | |
| Merostomata | 1 | 1 | 1 |
| Crustacea | 46 | 71 | 94 |
| Myriapoda | 1 | 1 | 1 |
| Insecta | 157 | 478 | 712 |
| Arachnida | 15 | 24 | 28 |
| Echinodermata | 6 | 8 | 11 |
| Prosopygia | 1 | 1 | 1 |
| Enteropneusta | 1 | 1 | 1 |
| Urochorda | 1 | 1 | 1 |
| Cephalochorda | 1 | 1 | 1 |
| Craniata (Classes) | | | |
| Pisces | 64 | 114 | 156 |
| Amphibia | 2 | 5 | 10 |
| Reptilia | 10 | 16 | 23 |
| Aves | 38 | 131 | 176 |
| Mammalia | 6 | 6 | 8 |
| Animals | 434 | 977 | 1364 |
| Plants | 77 | 147 | 204 |
| Total Collections | 511 | 1124 | 1568 |

FAUNA

Phylum COELENTERATA

Class Hydromedusae

Hydractinidae

⁵*Hydractinia echinata* Fleming Spiny Polymorphic Hydroid

Class Scyphomedusae

Pelagidae

⁵*Chrysaora quinquecirrha* Desor Jellyfish

Rhizophysaliidae

Physalia pelagica Bosc Portuguese Man-of-War

Phylum PLATYHELMINTHES — Flatworms

Class Turbellaria — Planarians

Bdellouridae

Bdelloura candida (Girard) Planaria

Phylum ANNELIDA — Segmented Worms

Class Chaetopoda

Chaetopteridae

⁵*Chaetopterus* sp.

Megascolecidae

Pontedrilus bermudensis Beddard

Class Hirudinea — Leeches

Piscicolidae

Myzobdella lugubris Leidy Leech

Phylum MOLLUSCA — Mollusks

Class Pelecypoda — Clams

Teredinidae — Ship Worms

⁵*Teredo* sp. Ship Worm

Order Nudibranchia

Corambidae

Corambella baratariae Harry Barataria Nudibranch

Dorididae

Doris verrucosa Linnaeus Verucose Slug

Class Gastropoda — Snails (Univalves)

Fissurellidae

Diadora cayenensis Lamarck Cayenne Keyhole Limpet

Vitrinellidae

Cyclostremella humilis Bush Humble Cyclostremella

Melongenidae — Large Whelks

⁶*Busycon contrarium*

Strombidae

Strombus alatus Gmelin Florida Fighting Conch

Class Cephalopoda — Cuttlefishes

Loliginidae

Doryteuthis plei (de Blainville) Squid

Loligo pealei LeSueur Peale's Squid

Lolliguncula brevis de Blainville Short Squid

Phylum ARTHROPODA — Segmented Animals

Class Crustacea — Crustaceans

Subclass Copepoda

Clausidiidae

⁴*Clausidium* sp.

Lernaeidae

Lernaenicus radiatus (LeSueur)

Pontellidae

¹*Anomalocera ornata* Sutcliffe

Subclass Cirripedia

Lepadidae

¹*Lepas anatifera* Linnaeus Goose Barnacle

¹*Lepas pectinata* Spengler Pectinate Goose Barnacle

Subclass Malacostraca

Order Amphipoda

Ampeliscidae

Ampelisca holmesi Pearse

Ampithoidae

³*Ampithoe longimanus* Smith

Cymadusa filosa Savigny

Atylidae

Atylus minikai (A. C. Walker)

³*Atylus* sp.

Bateidae

³*Batea* sp.

Caprellidae

Caprella carolinensis Mayer

Carolina Caprella

³*Hemiaegena minuta* Mayer

Corophiidae

³*Corophium acherusicum* Costa

³*Erithonius brasiliensis* (Dana)



Figure 5. Winter fences before hurricane (Gulf side)



Figure 6. Winter fences after hurricane (Gulf side)

| | | |
|--|----------|---------------------|
| <i>Gammaridae</i> | | |
| <i>Carinogammarus mucronatus</i> (Say) | | |
| <i>Haustoriidae</i> | | |
| ³ <i>Haustorius mexicanus</i> Bousfield | | |
| <i>Oedicerotidae</i> | | |
| ³ <i>Monoculodes edwardsi</i> Holmes | | |
| <i>Photidae</i> | | |
| ³ <i>Microprotopus raneyi</i> Wigley | | |
| <i>Talitridae</i> — Sandfleas | | |
| ³ <i>Orchestia grillus</i> (Bosc) | | |
| ³ <i>Orchestia platensis</i> Krøyer | | |
| ³ <i>Talorchestia</i> sp. No. 1 | | |
| ³ <i>Talorchestia</i> sp. No. 2 | | |
| Order Isopoda | | |
| <i>Cymothoidae</i> | | |
| <i>Livoneca ovalis</i> (Say) | | |
| <i>Idotheidae</i> | | |
| <i>Erichsonella attenuata</i> (Harger) | | |
| <i>Sphaeromidae</i> | | |
| <i>Ancinus depressus</i> (Say) | | |
| Order Stomatopoda | | |
| <i>Squillidae</i> | | |
| <i>Lysiosquilla excavatrix</i> Brooks | | Mantis Shrimp |
| <i>Lysiosquilla scabricauda</i> (Lamarck) | | Mantis Shrimp |
| Order Decapoda | | |
| Suborder Macrura | | |
| <i>Alpheidae</i> — Snapping Shrimp | | |
| ⁵ <i>Crangon</i> (<i>Alpheus</i>) <i>heterochelis</i> (Say) | | |
| <i>Hippolytidae</i> | | |
| <i>Hippolyte zostericola</i> (Smith) | | Eel-Grass Shrimp |
| <i>Tozeuma carolinense</i> Kingsley | Carolina | Eel-Grass Shrimp |
| <i>Palaemonidae</i> | | |
| <i>Palaemonetes vulgaris</i> Say | | Common Grass Shrimp |
| <i>Penaeidae</i> | | |
| ⁵ <i>Trachypeneus constrictus</i> (Stimpson) | | |
| <i>Ogyrididae</i> | | |
| <i>Ogyrides alphaerostis</i> (Kingsley) | | Ogyrides |
| <i>Processidae</i> | | |
| <i>Processa</i> sp. | | Processa |
| Suborder Brachyura | | |
| <i>Calappidae</i> | | |
| <i>Calappa sulcata</i> Rathbun | | Box Crab |

| | | |
|--|--------------|-----------------------|
| <i>Grapsidae</i> | | |
| ⁶ <i>Sesarma cinereum</i> (Bosc) | | Wharf Crab |
| <i>Majidae</i> (Maidae) | | |
| ¹ <i>Metoporphaphis calcarata</i> (Say) | "Calcareous" | Spider Crab |
| <i>Portunidae</i> | | |
| <i>Ovalipes quadulpensis</i> (de Saussure) | | Lady Crab |
| ¹ <i>Portunus gibbesii</i> (Stimpson) | | Swimming Crab |
| <i>Xanthidae</i> | | |
| <i>Panopeus herbstii</i> (H. Milne Edwards) | | Herbst's Mud Crab |
| ⁵ <i>Panopeus</i> sp. | | Mud Crab |
| Suborder Anomura | | |
| <i>Albuneidae</i> | | |
| <i>Albunea gibbesii</i> (Stimpson) | | Sand Crab |
| <i>Lepidopa benedicti</i> Schmitt | | Sand Crab |
| <i>Callianassidae</i> | | |
| <i>Callianassa islagrande</i> Schmitt | | Grand Isle Calianassa |
| <i>Paguridae</i> | | |
| <i>Clibanarius vittatus</i> (Bosc) | | Striped Hermit Crab |
| <i>Paguristes hummi</i> Wass | | Hermit Crab |
| <i>Pagurus impressus</i> (Benedict) | | Impressed Hermit Crab |
| <i>Petrochirus bahamensis</i> (Herbst) | | Red Hermit Crab |
| <i>Porcellanidae</i> | | |
| <i>Polyonyx gibbesi</i> (Haig) | | Gibb's Polyonyx |

¹Species collected by E. A. Richmond (1962-1966); ²H. J. Bennett;
³Douglas Farrell; ⁴Philip J. Phillips; ⁵Gordon Gunter—unpublished
data; ⁶David Peterson. Remainder taken from a Gulf Coast Research
Laboratory list.

CLASS INSECTA (HEXAPODA) — INSECTS

Odonata — Dragonflies, Damselflies

Lestidae

Lestes sp.

Libellulidae

Tarnetrum corruptum Hagen

Orthoptera — Grasshoppers, Crickets, Roaches, et al.

Gryllidae

Nemobius fasciatus (DeG.)

Hemiptera — True Bugs

Coreidae

Alydus pilosulus (Herrich-Schaeffer)

Hydrometridae

Hydrometra martini Kirkaldy

Lygaeidae
Pachybrachius servillei (Guerin)
Miridae
Psallus seriatus (Reuter)
Nepidae
Ranatra australis Hungerford
Notonectidae
Notonecta indica Linnaeus
Pentatomidae
Banasa dimidiata (Say)
Reduviidae
Rasahus hamatus (Fab.)
Homoptera — Aphids, Leafhoppers, et al.
Acanaloniidae
Acanalonia latifrons (Walker)
Aphidiidae
Aphis gossypii Glover
Prociphilus sp.
Cercopidae
Prosapia bicincta (Say)
Cicadellidae
Draeculacephala bradleyi Van Duzee
Draeculacephala portola Ball
Draeculacephala producta (Walker)
Tylozygus fasciatus (Walker)
Flatidae
Ormenoides venusta (Melichar)
Membracidae
Cyrtolobus tuberosa (Fairmaire)
Spissistilus festinus (Say)
Neuroptera — Lacewing-flies, antlions, et al.
Ascalaphidae
Ululodes hageni Weele
Chrysopidae
Chrysopa oculata Say
Myrmeleontidae
Paranthaclisis hageni (Bks)
Lepidoptera — Butterflies, moths, skippers
Suborder Heterocera, Superfamily Noctuoidea
Arctiidae — Tiger Moths
Apantesis nais Drury

Diacrisia virginica (Fab.)
Hyphantria cunea (Drury)
 Eucleidae — Slug Caterpillars
Euclea sp.
Sibine stimulea Clem.
 Olethreutidae
Bactra verutana verutana Zeller
 Phalaenidae (Noctuidae) — Noctuids
Acronicta tritona (Hbn.)
Euagrotis sp.
Euthisanotia unio Hbn.
Feltia subterranea (Fab.)
Leucania sp.
Orthodes crenulata Bth.
Tarachidia candefacta (Hbn)
 Geometridae — Geometrids
Semiothisa sp.
 Megalopygidae
Lagoa crispata Packard
 Pyrallidae
Diatraea sp.
Nomaphila noctuella (D. & G.)
 Gelechiidae
Aroga coloradella (Bsk.)
Dichomeris ligulella (Hbn.)
Filatima sp.
 Blastobasidae
Holcocera sp.
 Yponomeutidae
Atteva punctella (Cramer)
 Diptera — Flies, Mosquitoes
 Bibionidae
Philia orbata (Osten Sacken)
 Bombyliidae
Anthrax tigrina (DeGeer)
 Ceratopogonidae
Atrichopogon sp. (complex)
 Chironomidae
Chironomus sp.
 Dolichopodidae
Condyllostylus chrysoprasi (Walker)

Ephydridae

Dimecoenia spinosa (Loew.)

Setacea sp.

Sciomyzidae

Pherbellia nana (Fallen)

Stratiomyidae

Hermetia illucens (Linnaeus)

Tachinidae

Archytas apicifer (Walker)

Sitophaga sp.

Therevidae

Furcifera sp.

Coleoptera — Beetles

Alleculidae

Hymenorus densus LeConte

Hymenorus distinctus Fall

Anobiidae

Ernobius granulatus LeConte

Petalium seriatum Fall

Tricorynus sp. nr. *gravis* LeConte

Anthicidae

Tomoderus sp.

Vacusus laetus Laf.

Bostrichidae

Amphicerus cornutus Pallus

Lichenophanes armiger (LeConte)

Stephanopachys rugosus (Olivier)

Buprestidae

Taphrocerus sp.

Taphrocerus schaefferi Nic. and Weiss

Byrrhidae

Limnichites sp.

Carabidae

Agonoderus lineola (Fab.)

Agonoderus partiaris Say

Agonoderus pauperculus Dej.

Agonum cincticollis Say

Bembidion contractum Say

Bradycellus rupestris Say

Chlaenius laticollis Say

Chlaenius niger Rand.

Dyschirius erythrocerus Lec.

Euphorticus pubescens Dej.
Loxandrus sp.
Selonophorus sp.
Tachys sp.
Tetragonoderus fasciatus Hald.

Cerambycidae

Arhopalus rusticus nubilus (LeConte)
Leptostylus sp. (probably *knulli* Fisher)

Chrysomelidae

Altica amoena Horn
Altica chalybea Illiger
Altica rufa Illiger
Chrysomela scripta Fab.
Graphops curtipennis Melsh.
Lema trilineata Olivier
Rhadiopterus sp.
Strabala rufa (Illiger)

Cicindelidae

Cicindela hamata lacerata Chd.
Cicindela hamata monti Vaurie

Coccinellidae

Ceratomegilla maculata DeGeer (*Coleomegilla maculata fus-*
cilabris Muls. = an aberration)
Chilocorus cacti Linnaeus
Chilocorus tripustulatus DeGeer
Hyperaspis signata Olivier

Colydiidae

Bothrideres geminatus (Say)

Cucujidae

Ahasverus rectus (DeGeer)

Curculionidae

Anthonomus sp.
Baris sp.
Hyperodes sp.
Listronotus blandus Henderson
Perigaster obscura LeConte
Sphenophorus necydaleides (Fab.)

Dytiscidae

Bidessus sp.
Copelatus glyphicus (Say)
Desmopachria grana (LeConte)

Elateridae

Blauta cribraria (Germar)
Conoderus amplicollis (Gyll.)
Conoderus falli Lane
Glyphonyx sp.
Hemicrepidius decolorata Say
Ischiodontus soleatus (Say)
Ischiodontus schwarzi Becker
Ischiodontus simplex (LeConte)
Lanelater sallei LeConte
Melanotus fissilis (Say)
Neotrichophorus carolinensis Schaeffer

Helodidae

Cyphon variabilis Thunb.
Scirtes tibialis Guerin

Heteroceridae

Heterocerus pallidus Say
Heterocerus pusillus Say

Hydrophilidae

Enochrus consors LeConte
Enochrus consortus Green

Lycidae

Celetes basalis LeConte

Monommidae

Hyporhagus punctulatus punctulatus Thomson

Melyridae

Collops floridanus Schaeffer
Collops sp.

Noteridae

Sulphisellus puncticallis Cresson

Omophronidae

Omophron sp.

Ostomidae

Temnochila virescens (Fab.)

Scarabaeidae

Ataenius cognatus LeConte
Ataenius gracilis Melsh.
Ataenius simulator Harold
Aphodius granarius Linnaeus
Diplotaxis bidentata LeConte
Euparia?

Parastasia brevipes (LeConte)

Phyllophaga dispar (Burm.)

Strategus julianus Burm.

Scolytidae

Xyleborus xylographus Say

Silphidae

Silpha surinamensis Fab.

Staphylinidae

Carpelinus sp.

Hesperobium sp.

Lathrobium simplex LeConte

Lobrathium sp.

Philonthus cunctans Horn

Tenebrionidae

Gondwanocrypticus obsoletus (Say)

Cybotus estriatus (LeConte)

Epitragodes tomentosus (LeConte)

Hymenoptera — Bees, Wasps, Ants, et al.

Braconidae — Braconids

Lysiphlebus testaceipes (Cresson)

Microplitis varicolor Viereck

Rogas laphygmae Viereck

Scoliidae — Scoliid Wasps

Campsomeris plumipes fossulana (Fab)

CLASS ARACHNIDA*

Araneida — Spiders

Dictynidae — Dictynids

Dictyna sublata Hentz

Drassidae — Drassids

Gnaphosa sericata Koch

Linyphiidae — Sheet-web Weavers

Ceraticelus similis Banks

Erigone autumnalis Emerton

Araneidae — Typical Orb-weavers

Araniella displicata (Hentz)

Argiopidae — Orb-weavers

Tetragnatha caudata Emerton

Tetragnatha pallescens (Cambridge)

Tetragnatha sp.

*—Collected by Richmond and deposited in the American Museum of Natural History, N. Y.

Thomisidae — Crab-spiders

Misumenops celer Hentz

Tibellus duttonii Hentz

Clubionidae — Clubionids

Meriola decepta Banks

Lycosidae — Wolf-spiders

Arctosa sublata Montgomery

Lycosa antelucana Montgomery

Pardosa pauxilla Montgomery

Pardosa saxatilis Hentz

Attidae — Jumping-spiders

Pellenes coronatus Hentz

Phylum ECHINODERMATA

Class Holothuroidea

Cucumariidae

⁵*Thyone mexicana*

Class Asteroidea

Arbaciidae

¹⁰*Arbacia punctulata* (Lamarck)

Purple Sea Urchin

Phylum PROSOPIGIA

Class Ectoprocta

Vesiculariidae

⁵*Amathia convoluta* Lamouroux

Phylum CHORDATA

Subphylum Cephalochordata (Acrania)

Branchiostomidae

Branchiostoma floridae Hubbs Florida Lancelet, Amphioxus

Subphylum Craniata (Vertebrata)

Class Pisces

Subclass Chondrichthyes — Cartilaginous Fishes

Order Squaliformes

Carcharhinidae — Requiem Sharks

^{1/11}*Carcharinus leucas* (Müller and Henle)

Bull Shark

^{1/11}*Carcharhinus limbatus* (Müller and Henle)

Blacktip Shark

¹⁶*Negaprion brevirostris* (Poey)

Lemon Shark

^{1/11}*Scoliodon terraenovae* (Richardson) Atlantic Sharpnose Shark

Sphyrnidae

^{15/16}*Sphyrna tiburo* (Linnaeus)

Bonnethead

Order Rajiformes (Batoidei)

Pristidae — Sawfishes

^{12/14}*Pristis pectinatus* Latham Common Sawfish

Torpedinidae — Electric Rays

^{14/15/17}*Narcine brasiliensis* (Olfers) Lesser Electric Ray

Rajidae — Skates

^{8/16}*Raja eglanteria* Bosc Skate, Brier Ray

¹⁷*Raja lentiginosa* Bigelow and Schroeder Freckled Skate

Dasyatidae

¹⁷*Dasyatis americana* Hildebrand and Schroeder Southern Stingray

¹⁷*Gymnura micrura* (Bloch and Schneider) Smooth Butterfly Ray

Subclass Osteichthyes — Bony Fishes

Order Seminotiformes

Lepisosteidae

¹⁶*Lepisosteus oculatus* (Winchell) Spotted Gar

Order Clupeiformes

Elopidae — Ladyfishes

¹⁶*Elops saurus* Linnaeus Ladyfish

Megalopidae — Tarpons

¹⁶*Megalops atlantica* Valenciennes Atlantic Tarpon

Clupeidae — Herrings

^{1/16}*Dorosoma petenense* (Günther) Threadfin Shad

Engraulidae

¹⁶*Anchoa mitchilli* (Valenciennes) Bay Anchovy

Order Cyprinodontiformes

Cyprinodontidae — Killifishes — Top Minnows

^{15/17}*Adinia xenica* (Jordan and Gilbert) Diamond Killifish

^{15/17}*Fundulus confluentus* Goode and Bean Marsh Killifish

¹⁶*Fundulus pulvereus* (Evermann) Bayou Killifish

Order Gadiformes

Gadidae — Codfishes

¹⁶*Urophycis floridanus* (Bean and Dresel) Southern Hake

Order Gasterosteiformes

Fistulariidae — Cornetfishes

⁴*Fistularia tabacaria* Linnaeus Cornetfish

Syngnathidae — Pipefishes, Seahorses

⁶*Syngnathus scovelli* (Evermann and Kendall) Scovell's Pipefish

Order Perciformes

Serranidae — Sea Basses

| | |
|--|----------------|
| ¹⁷ <i>Centropristes ocyurus</i> (Jordan and Evermann) | Bank Sea Bass |
| ⁴ <i>Centropristes philadelphicus</i> (Linnaeus) | Rock Sea Bass |
| ¹ <i>Diplectrum arcuarium</i> Ginsburg | Sandfish |
| ⁹ <i>Mycteroperca bonaci</i> (Poey) | Black Grouper |
| ⁸ <i>Mycteroperca phenax</i> (Jordan and Swain) | Scamp |
| ⁶ <i>Serraniculus pumilio</i> Ginsburg | Pigmy Sea Bass |

Lutjanidae — Snappers

| | |
|---|--------------|
| ¹⁷ <i>Lutjanus campechanus</i> | Red Snapper |
| ^{1/10} <i>Lutjanus synagris</i> (Linnaeus) | Lane Snapper |

Priacanthidae

| | |
|--|--------------|
| ¹⁷ <i>Pristigenys alta</i> (Gill) | Short Bigeye |
|--|--------------|

Pomatomidae — Bluefishes

| | |
|--|----------|
| ^{1/4} <i>Pomatomus saltatrix</i> (Linnaeus) | Bluefish |
|--|----------|

Carangidae — Jacks

| | |
|---|-------------|
| ⁴ <i>Alectis crinitis</i> (Mitchill) | Threadfish |
| ⁴ <i>Caranx hippos</i> (Linnaeus) | Common Jack |
| ¹⁶ <i>Caranx crysos</i> (Mitchill) | Blue Runner |
| ⁴ <i>Chloroscombrus chrysurus</i> (Linnaeus) | Bumper |

Pomadasyidae — Grunts

| | |
|--|---------|
| ^{1/14/18} <i>Orthopristis chrysopterus</i> (Linnaeus) | Pigfish |
|--|---------|

Sciaenidae — Drums

| | |
|---|-------------------|
| ¹¹ <i>Menticirrhus americanus</i> (Linnaeus) | Southern Kingfish |
| ¹⁸ <i>Stellifer lanceolatus</i> (Holbrook) | Star Drum |
| ¹⁷ <i>Cynoscion arenarius</i> Ginsburg | Sand Sea Trout |
| ¹⁷ <i>Cynoscion nothus</i> (Holbrook) | Silver Sea Trout |

Ephippidae — Spadefishes

| | |
|--|-----------|
| ¹² <i>Chaetodipterus faber</i> (Broussonet) | Spadefish |
|--|-----------|

Pomacentridae — Damselfishes

| | |
|--|----------------|
| ^{7/8} <i>Abudefduf saxatilis</i> (Linnaeus) | Sergeant Major |
|--|----------------|

Labridae — Wrasse

| | |
|--|----------------|
| ¹⁷ <i>Halichoeres radiatus</i> (Linnaeus) | Puddingwife |
| ¹¹ <i>Halichoeres caudalis</i> (Poey) | Painted Wrasse |
| ^{13/18} <i>Hemipteronotus novacula</i> (Linnaeus) | Razorfish |

Scombridae — Tunas, Mackerels

| | |
|--|------------------|
| ⁴ <i>Scomberomorus maculatus</i> (Mitchill) | Spanish Mackerel |
|--|------------------|

Xiphiidae — Swordfishes

| | |
|---|-----------|
| ¹⁴ <i>Xiphias gladius</i> Linnaeus | Swordfish |
|---|-----------|

Eleotridae — Sleepers

| | |
|---|--------------------|
| ^{15/18} <i>Eleotris pisonis</i> (Gmelin) | Spinycheck Sleeper |
|---|--------------------|

Gobiidae — Gobies

| | |
|---|--------------------|
| ^{4/17} <i>Gobioides broussonneti</i> Lacépède | Violet Goby |
| ¹⁶ <i>Gobionellus boleosoma</i> (Jordan and Gilbert) | Darter Goby |
| ¹ <i>Gobiosoma longipala</i> Ginsburg | Naked Goby |
| ¹⁷ <i>Gobiosoma</i> sp. | Goby |
| ¹⁶ <i>Gobiosoma bosci</i> (Lacépède) | Naked Goby |
| ¹ <i>Gobiosoma robustum</i> Ginsburg | Naked Goby |
| ¹⁶ <i>Microgobius gulosus</i> (Girard) | Large-mouthed Goby |
| ¹⁵ <i>Evorthodus lyricus</i> (Girard) | Lyre Goby |

Scorpaenidae — Rockfishes, Scorpionfishes

| | |
|--|---------------------------|
| ¹⁷ <i>Scorpaena dispar</i> Longley and Hildebrand | Hunchback Scorpionfish |
| ¹¹ <i>Scorpaena grandicornis</i> Cuvier | Lionfish |
| ^{11/17} <i>Scorpaena plumieri</i> Bloch | Scorpion Fish |

Triglidae

| | |
|---|-------------------|
| ¹⁷ <i>Prionotus martis</i> Ginsburg | Barred Searobin |
| ¹⁷ <i>Prionotus rubio</i> Jordan | Blackfin Searobin |
| ^{16/17} <i>Prionotus scitulus</i> Jordan and Gilbert | Slender Searobin |
| ¹⁷ <i>Prionotus tribulus</i> Cuvier | Bighead Searobin |
| ¹⁷ <i>Prionotus</i> sp. | Searobin |

Blenniidae — Combtooth Blennies

| | |
|--|-----------------|
| ⁴ <i>Hypsoblennius hentzi</i> (LeSueur) | Feather Blenny |
| ⁴ <i>Hypsoblennius ionthas</i> (Jordan and Gilbert) | Freckled Blenny |

Ophidiidae — Cusk-eels

| | |
|--|--------------------|
| ¹ <i>Lepophidium graellsii</i> (Poey) | Blackedge Cusk-eel |
| ¹ <i>Ophidion</i> sp. | Cusk-eel |
| ¹ <i>Ophidion welshi</i> (Nichols and Breder) | Crested Cusk-eel |
| ^{15/16} <i>Otophidium</i> sp. | Cusk-eel |

Sphyraenidae — Barracudas

| | |
|--|-----------------|
| ^{7/10} <i>Sphyraena barracuda</i> (Walbaum) | Great Barracuda |
| ^{15/16} <i>Sphyraena guachancho</i> Cuvier | Guachanche |

Order Pleuronectiformes

Bothidae — Lefteye Flounders

| | |
|--|--------------------|
| ¹⁷ <i>Ancyloperetta quadrocellata</i> Gill | Ocellated Flounder |
| ⁴ <i>Citharichthys macrops</i> Dresel | Spotted Whiff |
| ^{16/17} <i>Etropus crossotus</i> Jordan and Gilbert | Fringed Flounder |
| ⁴ <i>Syacium gunteri</i> Ginsburg | Gunter's Flounder |

Soleidae

| | |
|---|--------------------------|
| ¹⁷ <i>Achirus lineatus</i> (Linnaeus) | Lined Sole |
| ^{16/17} <i>Trinectes maculatus</i> Bloch and Schneider | Broad Sole, Hogchoker |

Order Echeneiformes

Echeneidae — Remoras

| | |
|--|-------------|
| ¹⁷ <i>Echeneis naucrates</i> Linnaeus | Sharksucker |
|--|-------------|

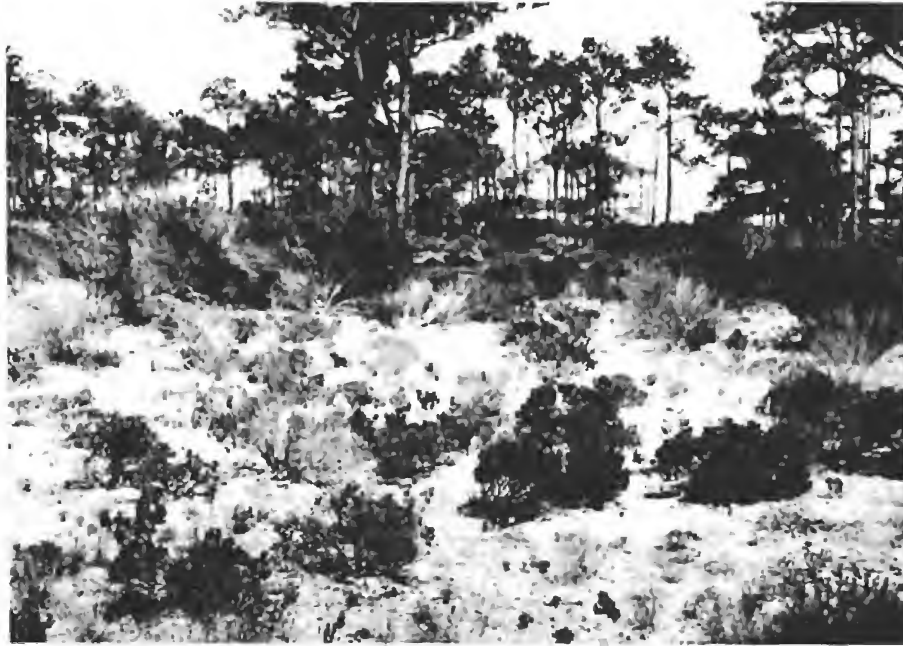


Figure 7. Typical scene of higher elevations in the interior of Horn Island (Slash Pine, Rosemary, Baccharis and Saw Palmetto)



Figure 8. Tracks of *Procyon lotor* in sand

Order Gobiesociformes

Gobiesocidae — Clingfishes

^{15/16}*Gobiesox strumosus* Cope Skilletfish

Order Tetraodontiformes

Balistidae — Filefishes, Triggerfishes

^{4/17}*Alutera schoepfi* (Walbaum) Orange Filefish

¹⁷*Balistes capriscus* Gmelin Gray Triggerfish

^{5/17}*Monacanthus ciliatus* (Mitchill) Fringed Filefish

^{1/17}*Monacanthus hispidus* (Linnaeus) Common Filefish

Tetraodontidae — Puffers

¹⁷*Sphaeroides nephelus* (Goode and Bean) Southern Puffer

Ostraciidae — Trunkfishes

^{2/11}*Lactophrys quadricornis* (Linnaeus) Cowfish

Order Batrachoidiformes

Batrachoididae — Toadfishes

²*Opsanus beta* (Goode and Bean) Toadfish, Oyster Dog

^{15/16}*Porichthys porosissimus* (Cuvier) Atlantic Midshipman

Order Lophiiformes

Antennariidae — Frogfishes

^{13/16}*Antennarius radiosus* Garman Singlespot Frogfish

⁴*Histrio histrio* (Linnaeus) Sargassum Fish

Ogcocephalidae — Batfishes

¹⁷*Ogcocephalus vespertilio* (Linnaeus) Longnose Batfish

⁶*Ogcocephalus* sp. Batfish

The numbers preceding the species indicate by whom the collection was made. Numbers 1, 2 and 3 are identical with the numbers used in my 1962 paper. The remainder refer to other collectors or references as follows: 4. Gulf Coast Research Laboratory; 5 C. E. Dawson; 6. H. Shoemaker (1955); 7. A. Myrberg; 8. H. T. Boschung; 9. Rohr, Ford and Brewster; 10. W. Demoran; 11. J. Y. Christmas; 12. W. Walley; 13. Gordon Garwood; 14. Wayne Watkins; 15. James B. Ward; 16. James Franks; 17. Gordon Gunter—unpublished data.

Class Amphibia — The Frogs, Toads, Salamanders

Hylidae

Hyla crucifer crucifer Wied.

Hyla femoralis Latreille

Hyla gratiosa LeConte

Pseudacris nigrata nigrata LeConte

Pseudacris ornata (Holbrook)

Sceloporus undulatus undulatus Latreille

Class Reptilia — The Reptiles

Testudinata — Turtles

Chelydridae

| | |
|---|------------------------|
| ³ <i>Chelydra serpentina serpentina</i> (Linnaeus) | Common Snapping Turtle |
|---|------------------------|

Class Aves — Birds

Colymbidae — Grebes

| | | |
|---|--------------|---|
| ⁵ <i>Colymbus auritus</i> Linnaeus | Horned Grebe | W |
|---|--------------|---|

Ardeidae — Herons and Bitterns

| | | |
|---|-----------------------|---|
| ³ <i>Ardea occidentalis occidentalis</i> Audubon | Great White Heron | T |
| ⁵ <i>Botaurus lentiginosus</i> (Backett) | American Bittern | S |
| ⁵ <i>Ardeola ibis ibis</i> (Linnaeus) | Cattle Egret | S |
| ^{1/3} <i>Dicromanassa rufescens rufescens</i> (Gmelin) | Reddish Egret | P |
| ^{3/5} <i>Florida caerulea caerulea</i> (Linnaeus) | Little Blue Heron | S |
| ¹ <i>Ixobrychus exilis exilis</i> (Gmelin) | Eastern Least Bittern | W |

Anatidae — Swans, Geese and Ducks

| | | |
|---|--------------------|---|
| ^{3/5} <i>Anas strepera</i> Linnaeus | Gadwell | W |
| ⁵ <i>Charitonetta albeola</i> (Linnaeus) | Bufflehead | W |
| ⁵ <i>Glaucionetta clangula americana</i> (Bonaparte) | American Goldeneye | W |
| ³ <i>Lophodytes cucullatus</i> (Linnaeus) | Hooded Merganser | W |
| ⁵ <i>Melanitta perspicillata</i> (Linnaeus) | Surf Scoter | M |
| ⁵ <i>Mergus merganser merganser</i> Cassin | American Merganser | W |
| ⁵ <i>Perissonetta collaris</i> (Donovan) | Ring-necked Duck | W |
| ⁵ <i>Spatula clypeata</i> (Linnaeus) | Shoveler | M |

Rallidae — Gallinules and Rails

| | | |
|---|------------|------|
| ⁴ <i>Laterallus jamaicensis jamaicensis</i> (Gmelin) | Black Rail | M, W |
| ^{3/5} <i>Porzana carolina</i> (Linnaeus) | Sora Rail | T, W |

Charadriidae — Plovers, Turnstones and Surfbirds

| | | |
|---|--------------------|---|
| ^{1/5} <i>Charadrius alexandrinus tenuirostris</i> (Lawrence) | Cuban Snowy Plover | S |
|---|--------------------|---|

Scolopacidae — Woodcocks, Snipes and Sandpipers

| | | |
|--|-------------------|---|
| ³ <i>Erolia maritima</i> (Brünnich) | Purple Sandpiper | T |
| ^{1/5} <i>Limnodromus griseus griseus</i> (Gmelin) | Eastern Dowitcher | T |

Laridae — Gulls and Terns

| | | |
|---|--------------------|---|
| ³ <i>Rissa tridactyla tridactyla</i> (Linnaeus) | Atlantic Kittiwake | T |
| ⁵ <i>Thalasseus sandvicensis acuflavidus</i> (Cabot) | Cabot Tern | S |

Columbidae — Pigeons and Doves

| | | |
|--|-------------------------|---|
| ³ <i>Columba livia livia</i> Gmelin | Rock or Domestic Pigeon | W |
| ⁵ <i>Zenaida asiatica asiatica</i> (Linnaeus) | White-winged Dove | T |

Tytonidae

| | | |
|--|----------|---|
| ⁶ <i>Tyto alba pratincola</i> (Bonaparte) | Barn Owl | P |
|--|----------|---|

| | | | |
|---|-------------------------------|-------|--|
| Caprimulgidae — Goatsuckers | | | |
| ^{1/3/5} <i>Caprimulgus carolinensis</i> Gmelin | Chuck-will's Widow | W | |
| ³ <i>Caprimulgus vociferus vociferus</i> Wilson | Eastern Whippoorwill | T | |
| Trochilidae — Hummingbirds | | | |
| ^{3/5} <i>Archilochus colubris</i> (Linnaeus) | Ruby-throated Hummingbird | M,T | |
| Picidae — Woodpeckers | | | |
| ³ <i>Dendrocopos pubescens pubescens</i> (Linnaeus) | Southern Downy Woodpecker | P | |
| ³ <i>Melanerpes erythrocephalus</i> (Linnaeus) | Eastern Red-headed Woodpecker | P,V,S | |
| Tyrannidae — Flycatcher | | | |
| ³ <i>Empidonax minimus</i> (Baird and Baird) | Least Flycatcher | M | |
| Corvidae — Crows and Jays | | | |
| ³ <i>Corvus ossifragus</i> Wilson | Fish Crow | P | |
| ³ <i>Cyanocitta cristata cristata</i> (Linnaeus) | Southern Blue Jay | P | |
| Paridae — Titmice | | | |
| ³ <i>Penthestes carolinensis guilloti</i> Oberholser | Louisiana Chickadee | P | |
| Troglodytidae — Wrens | | | |
| ³ <i>Telmatodytes palustris palustris</i> (Wilson) | Long-billed Marsh Wren | P | |
| ³ <i>Nannus troglodytes hiemalis</i> (Vieillot) | Eastern Winter Wren | W | |
| Mimidae — Mockingbirds and Thrashers | | | |
| ³ <i>Toxostoma rufum rufum</i> (Linnaeus) | Brown Thrasher | M,W | |
| Vireonidae — Vireos | | | |
| ³ <i>Vireo sylvia gilva gilva</i> (Vieillot) | Eastern Warbling Vireo | M | |
| Parulidae — (Compsothlypidae) — Wood Warblers | | | |
| ³ <i>Dendroica caerulescens</i> (Gmelin) | Black-throated Blue Warbler | M | |
| ³ <i>Seiurus motacilla</i> (Vieillot) | Louisiana Waterthrush | S | |
| ³ <i>Wilsonia citrina</i> (Boddaert) | Hooded Warbler | M,S | |
| Icteridae — Meadowlarks, Blackbirds and Oriole | | | |
| ^{1/3/5} <i>Icterus spurius</i> (Linnaeus) | Orchard Oriole | S,M | |
| ⁵ <i>Icterus galbula</i> (Linnaeus) | Baltimore Oriole | M | |
| ³ <i>Sturnella magna argutula</i> Bangs | Southern Meadowlark | W,T | |
| Thraupidae — Tanagers | | | |
| ^{1/3/5} <i>Piranga olivacea</i> (Gmelin) | Scarlet Tanager | M | |
| ^{3/5} <i>Piranaga rubra rubra</i> (Linnaeus) | Summer Tanager | M,T | |
| Fringillidae — Grosbeaks, Finches, Sparrows and Buntings | | | |

- ^{2/1}*Passerina ciris ciris* (Linnaeus) Painted Bunting M,W
³*Zonotrichia albicollis* (Gmelin) White-throated Sparrow M,W

Additions by the following observers to the 1962 list, published in Volume 1 (no.2) of the Gulf Research Reports.

1. E. A. Richmond; 2. J. R. Walther; 3. W. I. Anderson; 4. K. E. Myers; 5. J. Blackard; 6. D. Peterson; 7. F. Carroll.

M = Migrant, P = Permanent resident, S = Summer resident, T = Transient or winter visitant, V = Summer visitant, W = Winter resident.

Class Mammalia — The Mammals

Order Chiroptera — Bats

Vespertilionidae — Vespertilionid — Bats

Myotis lucifugus lucifugus (LeConte) Little Brown Myotis

Order Rodentia — Rodents

Capromyidae — Nutrias and Coypus

Myocastor coypus bronariensis

(E. Geoffrey St. — Hilaire) Coypus

Muridae

Mus musculus (Linnaeus) House Mouse

FLORA

THALLOPHYTA

Phaeophyta — Brown Algae

Dictyotaceae

²*Dictyota dichotoma* (Hudson) Lamouroux Dictyota

Ectocarpaceae

Ectocarpus confervoides (Roth) LeJod. Ectocarpus

²*Ectocarpus siliculosus* (Dillwa.) Lyngb. Ectocarpus

Sargassaceae

²*Sargassum fluitans* Borgesen Sargassum

²*Sargassum natans* (Linnaeus) Sargassum

Charophyta — Brittleworts

Characeae

²*Chara* sp. Chara

Chlorophyta — Green Algae

Caulerpaceae

²*Caulerpa prolifera* (Forsk.) Lamouroux Caulerpa

Cladophoraceae

²*Chaetomorpha gracilis* Kützinger Chaetomorpha

| | |
|---|------------------------|
| ² <i>Cladophora blomquistii</i> Aziz and Humm | Cladophora |
| ² <i>Cladophora gracilis</i> (Griffiths) Kütz. | Cladophora |
| <i>Ulvaceae</i> | |
| <i>Enteromorpha prolifera</i> (Müll.) J. Ag. | Enteromorpha |
| <i>Rhodophyta</i> — Red Algae | |
| <i>Ceramiales</i> | |
| ² <i>Spyridia filamentosa</i> (Wulfen) Harvey | Spyridia |
| <i>Champiaceae</i> | |
| ² <i>Champia parvula</i> (C. Agardh) Harvey | Champia |
| <i>Chantransiaceae</i> | |
| ² <i>Acrochaetium seriatum</i> Borgesen | Acrochaetium |
| <i>Gracilariaceae</i> | |
| ² <i>Gracilaria verrucosa</i> (Hudson) Papenfuss | Gracilaria |
| <i>Hypneaceae</i> | |
| ² <i>Hypnea musciformis</i> (Wulfen) Lamouroux | Hypnea |
| <i>Rhodomelaceae</i> | |
| ² <i>Chondria baileyana</i> (Montague) Harvey | Chondria |
| ² <i>Chondria cnicophylla</i> (Melvill) De Toni | Chondria |
| ² <i>Chondria littoralis</i> Harvey | Chondria |
| ² <i>Laurencia poitei</i> (Lamouroux) Howe | Laurencia |
| <i>Cyanophyta</i> — Bluegreen Algae | |
| <i>Myxophyceae</i> | |
| ² <i>Dichothrix penicillata</i> Zanardini | Dichothrix |
| <i>Pteridophyta</i> | |
| <i>Osmundaceae</i> | |
| <i>Osmunda regalis</i> Linnaeus | Royal Fern |
| <i>Spermatophyta</i> | |
| <i>Gramineae</i> | |
| <i>Andropogon maritimus</i> Chapman | Seaside Broom Grass |
| ⁵ <i>Aristida spiciformis</i> Elliott | "Spike-like" Awn Grass |
| <i>Cynodon dactylon</i> (Kuntze) | Bermuda Grass |
| <i>Distichlis spicata</i> (Linnaeus) Greene | Spike-grass |
| [*] <i>Echinochla</i> (<i>Panicum</i>) <i>crus-galli</i> (L.) Beauvoir | Barnyard-grass |
| <i>Cyperaceae</i> | |
| <i>Elocharis acicularis</i> (L.) R. + S. | |
| <i>Fimbristylus spadicea</i> (L.) Vahl. | Chestnut-colored Sedge |
| (Plants previously identified as <i>F. Harperi</i> and <i>F. castanea</i>) | |

*—Listed previously but generic name changed 2. Collected by R. B. Channell (1966); 4. collected by S. M. Tracy (1898-1903); 5. collected by D. L. Diener (1953). Unnumbered species collected by Richmond (1962-1966). Deposited in the Bailey Herbarium at Cornell University or at the Philadelphia Academy of Natural Sciences.

are probably *F. spadicea* according to A. E. Schuyler)
**Fuirena scirpoides* Michx. Umbrella-grass

Xyridaceae

Xyris flabelliformis Chapman Flabellate Yellow-eyed grass

Haemodoraceae

Lacnantes tinctoria (Walt.) Ell. Red Root

Amaryllidaceae

Allium canadense Linnaeus Wild Garlic

Iridaceae

**Sisyrinchium atlanticum* Bicknell Atlantic Blue-eyed Grass

**Sisyrinchium nanum* Bicknell Blue-eyed Grass

Orchidaceae

Spiranthes floridana Wherry Ladies Tresses

Polygonaceae

**Polygonella gracilis* (Nutt.) Meisner Slender Jointweed

(Same as *Delopyrum gracilis* Nutt.)

Polygonum opelousanum Riddell Opelousas Smartweed

Amaranthaceae

Achyranthes philoxeroides (Mart.) Standley Chaff Flower

Capparidaceae

**Polanisia tenuifolia* Torrey & Gray Caper

Cruciferae

Cakile fusiformis Greene Cakile

Lepidium virginicum Linnaeus Poor-man's Pepper

Rosaceae

Rubus mississippianus Bailey Southern Dewberry

(Listed previously as *R. trivialis* (Michaux))

Oxalidaceae

Xanthoxalis filipes Small Slender-stalked Oxalis

Euphorbiaceae

Euphorbia cordifolia (Ell.) Small Spurge

Euphorbia sp. Spurge

Malvaceae

Kosteletzyka virginica (L.) Presl. Seashore-mallow

Kosteletzyka althaeifolia (Chap.) A. Gray Seashore-mallow

Cistaceae

Helianthemum arenicola Chapman Sanddune Frostweed

Helianthemum canadense (L.) Michaux Frostweed

Helianthemum georgianum Chapman Rock Rose

Lechea tenuifolia Michaux Rock Rose

| | | |
|--|----------------------|-------------------------|
| <i>Violaceae</i> | | |
| <i>Viola vittata</i> Greene | | White Violet |
| <i>Melastomataceae</i> | | |
| <i>Rhexia alifanus</i> Walt. | | Meadow-beauty |
| <i>Cornaceae</i> | | |
| <i>Svida stricta</i> Lamarck (Small) | | Lamarck's Dogwood |
| <i>Umbelliferae</i> | | |
| <i>Ptilimnium capillaceum</i> (Michaux) Ref. | Mock's Bishop's Weed | |
| <i>Ericaceae</i> | | |
| <i>Vaccinium Darrowi</i> Camp | | Darrow's Blueberry |
| <i>Primulaceae</i> | | |
| <i>Centrunculus minimum</i> Linnaeus | | Small's Chaffweed |
| <i>Convolvulaceae</i> | | |
| <i>Ipomoea sagittata</i> Cav. | | Sagittate Morning-glory |
| <i>Scrophulariaceae</i> | | |
| <i>Linaria floridana</i> Chapman | | Florida Toadflax |
| <i>Lentibulariaceae</i> | | |
| <i>Pinguicula lutea</i> Walter | | Yellow Butterwort |
| <i>Utricularia subulata</i> Linnaeus | | Awl-shaped Bladderwort |
| <i>Compositae</i> | | |
| <i>Cirsium horridulum</i> Elliotti | | Purple Thistle |
| (Forma Elliotti (T. & G.) Fernald) | | |
| ⁴ <i>Coreopsis corninsularis</i> Sherff | | Horn Island Tick-seed |
| <i>Erechtites hieracifolia</i> (L.) Raf. | | Pilewort, Fireweed |
| <i>Helenium amarum</i> (Rab.) H. Rock | | Sneezeweed |

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Figure 9. From Gulf to North (Section 29)



Figure 10. Looking West — last of trees — near Section 24

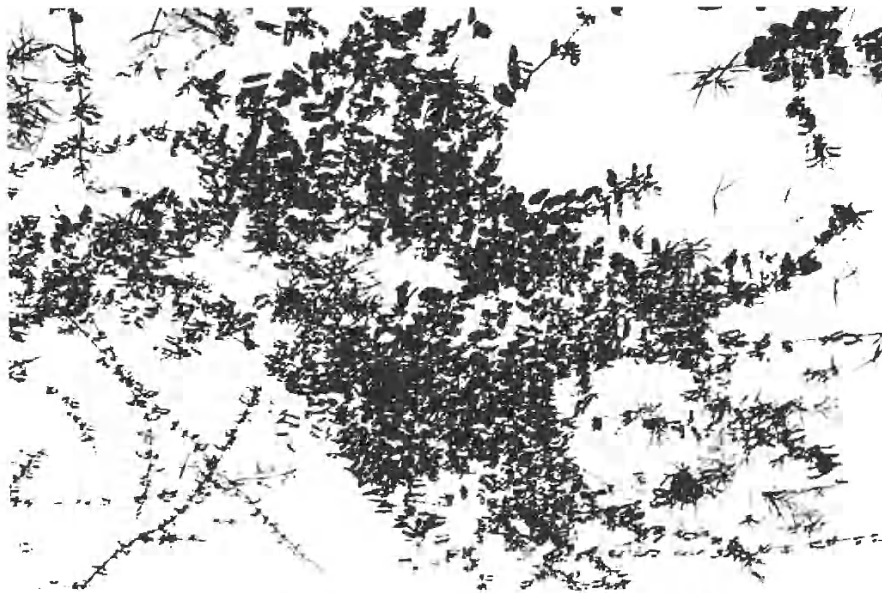


Figure 11. *Euphorbia cordifolia* (Ell.) Small — Spurge



Figure 12. *Opuntia humifusa* Raf. — Rafinesque's Prickly Pear

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CORRIGENDA

Of

"The Fauna and Flora of Horn Island, Mississippi,"
(Gulf Research Reports, Volume 1, No. 2, pp. 59-106, 1962)

- p. 62, line 1: Fields = Field
- p. 70, line 37: *Andara* = *Anadara*
- p. 71, line 36: *Marcrocallista* = *Macrocallista*
- p. 74, line 23: *Malacostra* = *Malacostraca*
- p. 74, line 30: *Taylorchestia longicornis* = *Talorchestia* sp.
- p. 74, line 43: *ocessatus* = *ocellatus*
- p. 75, line 7: *Emargonarta* = *emarginata*
- p. 78, line 4: *Lygus apicalis* Fieber = *Taylorilygus pallidulus* Blanchard
- p. 78, line 19: *Pangaeus bilineatus* (Say) = *Cydnidae*
- p. 78, line 40: *Graminella nigrifrons* = Delete "Probably *fascifrons* (Stål)"
- p. 78, line 43: *Macrosteles divisus* (Uhler) = *M. fascifrons* (Stål)
- p. 80, line 15: *Crambus* sp. = Place in Crambidae
- p. 81, line 11: *canithorax* = *mississippiensis* Hoffman
- p. 83, line 8: (Fall) = (Fall.)
- p. 83, line 39: *Dorilas* sp. = *Pipunculus*
- p. 83, line 46: Genus? = belongs under *Rhagionidae*
- p. 87, line 7: *serialis* = *seriata*
- p. 87, line 10: *Sylvanus* = *Silvanus*
- p. 88, line 26: *Photuris pennsylvanica* (DeGeer) = probably *P. versicolor* (Fab.) per McDermott

- p. 90, line 22: *Dorymymex* = *Dorymyrmex*
- p. 91, line 15: Delete and use *Linyphiidae* - Linyphiids
- p. 92, line 5: Urochorda = Urochordata
- p. 93, line 10: *Carnax* = *Caranx*
- p. 93, line 26: *Micropogen* = *Micropogon*
- p. 94, line 14: *albiguttus* = *albigutta*
- p. 94, line 15: *lethostigmus* = *lethostigma*
- p. 96, line 7: Gannet = *Sulidae*. Insert on p. 95 after *Pelecanidae*
- p. 96, line 43: Black bellied = hyphenate
- p. 97, line 35: Kingbord = Kingbird
- p. 98, line 5: *Hylochichla* = *Hylocichla*
- p. 99, line 23: *Mus* = *Rattus*, Author of species = (Berkenhout)
- p. 100, line 9: Bitter Beachgrass
- Fig. 26, line 2: groundsell = groundsel
- p. 101, line 31: *carymbosa* = *corymbosa*
- p. 102, line 35: Rafinewque's = Rafinesque's
- p. 103, line 12: stellaria = stellaris
- p. 104, line 2: Thistle = Actinospermum
- p. 104, line 4: Groundsell = Groundsel
- p. 104, line 10: recurring = recurving
- p. 105, line 20: 1946 = 1956

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Seasonal Occurrence of the Pelagic Copepoda in Mississippi Sound

by

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ABSTRACT

Collections of planktonic copepods from Mississippi Sound were made from January 1965 to March 1966. The following fifteen free-living copepods were identified: *Eucalanus pileatus*, *Paracalanus parvus*, *Centropages hamatus*, *Centropages furcatus*, *Temora stylifera*, *Temora longicornis*, *Labidocera aestiva*, *Labidocera* species, *Acartia tonsa*, *Oithona brevicornis*, *Oithona* species, *Oncaea venusta*, *Corycaeus* species, *Sappharina nigromaculata* and *Euterpina acutifrons*.

It was found that there is a definite seasonal distribution of copepods in Mississippi Sound with peak populations of copepods occurring in the spring, summer and fall.

INTRODUCTION

The copepods have a vital role in the economy of the sea. Clarke (1957) referred to them as "key industry animals," thus indicating that they act to convert the phytoplankton into a form of food available to larger animals in the environment that are not able to feed directly on the phytoplankton. Knowledge of the abundance and seasonal occurrence of the copepods is of fundamental importance.

The literature published on copepods of the Gulf of Mexico is sparse. Herrick (1887) published a list of a number of copepods collected from the northern Gulf Coast. His investigations extended from the west coast of Florida to the Gulf Coast of Alabama. Foster (1904) reported on the copepods collected from the area around the Gulf Biologic Station in Louisiana. King (1949) published a list of species taken in a ten-month survey of the west coast of Florida. Davis (1949) also published a composite and updated list of the copepods collected from a number of stations located on both the east and west coasts of Florida, which included both marine and brackish water forms. Jones (1952) conducted a preliminary survey of copepods from the Florida Current. His work included notes on the seasonal distribution and vertical distribution of the copepods in that region. Owre (1962) compiled a composite list of 129 species of copepods which were found in the Florida Current. This list was amend-

ed by Owre and Foyo (1964) and 45 species were added to the original list, making a total of 174 species of copepods identified from the Florida Current. Owre and Foyo (1967) published an illustrated key to the copepods found in the Florida Current. Schmidt (1954) reviewed all studies of copepods of the Gulf of Mexico and estimated "that close to a hundred free-swimming copepods, representative of some 70 genera, have to date been taken in the Gulf of Mexico and brackish waters adjacent thereto." Grice (1956) conducted a qualitative and quantitative seasonal study of the copepods of Alligator Harbor, Florida. Fleminger (1957) and Grice (1960) reported on various specific genera and added several new species to the ever growing list of species found in the Gulf of Mexico. Gonzalez (1957) reported on the seasonal distribution of the copepods of the Mississippi Delta region. Hopkins (1966) listed several copepods taken in the St. Andrew Bay System, Florida, with notes on their seasonal occurrence there. Woodmansee (1958) reported on a study of the seasonal distribution of the zooplankton off Chicken Key in Biscayne Bay, Florida, and Richmond (1962) listed one species of copepod collected near the beach of Horn Island in the Mississippi Sound.

The purposes of this investigation were to determine: (1) the quantitatively important species of copepods in the Mississippi Sound region of the Northern Gulf of Mexico; and (2) the relative abundance of each species through the course of a year.

DESCRIPTION OF THE MISSISSIPPI SOUND

According to Moore (1961), Mississippi Sound is an elongated body of water partially enclosed by a series of barrier islands. The Sound is approximately eighty miles long by ten miles wide, with an average depth of about ten feet (Figure 1). The axis of the sound is almost due east and west. The eastern boundary is the eastern end of Dauphin Island, near the lower end of Mobile Bay, and the western end terminates at Grand Island, Louisiana. Moore (1961) stated that the bottom is mud, but this is replaced by sand close to the barrier islands and in some places along the mainland. The eastern one-third of the Mississippi Sound lies in Alabama.

The major fresh water entry into Mississippi Sound is the Pascagoula River which empties into the Sound near the Alabama-Mississippi border, and the Pearl River which flows into the Sound about four miles west of Grand Island. In addition to these two rivers, fresh water flows into the Sound through Biloxi Bay and the Bay of St. Louis. Biloxi Bay is supplied with fresh water by the Biloxi River, the Tchouticabouffa River, Old Fort Bayou and Bernard Bayou. The Bay of St. Louis is supplied by the Jourdan and Wolf Rivers.

MATERIALS AND METHODS

Field Procedure

Once each month through the period January 1965 to March 1966, zooplankton collections were made at 10:00 A. M. All of these collections were made at a station located in Mississippi Sound, lying in Latitude 30° 17' N. and Longitude 88° 45' W. (Figure 1).

Each collection was made by towing a Clarke-Bumpus quantitative plankton sampler (Clarke and Bumpus 1940 and 1950) four times

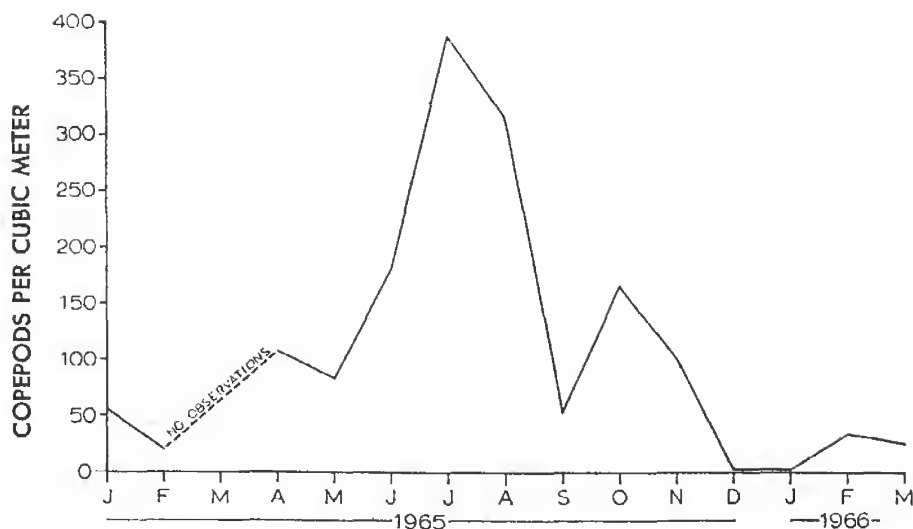


Figure 2. Average number of adult copepods per cubic meter by months. Dashed line indicates no observations.

DISCUSSION OF BIOLOGICAL DATA

The Total Copepod Population

Fifteen free-living copepods were identified in the plankton samples. Twelve were identified to species and three only to genus. Nine of these belong to the Order Calanoida, five to the Order Cyclopoida and one to the Order Harpacticoida. The Order Calanoida contained the greatest number of individuals with 81 per cent of all copepods collected in Mississippi Sound (Table 1). The cyclopoids ranked second in abundance and collectively accounted for 14 per cent of the total number of copepods. Although one species occurred quite frequently, individuals of the Order Harpacticoida were rare and comprised but 5 per cent of all copepods.

The monthly distribution of the entire copepod population at the collecting station in Mississippi Sound is given in Figure 2. Three modes of abundance of copepods are apparent—a small one in April 1965, the maximum in July and August 1965, and a minimum peak in October 1965. The first maximum followed a phytoplankton "bloom" which occurred in the second week of April. This phytoplankton "bloom" was apparently the result of a thorough mixing of the Sound by high winds during March and the first week of April. According to Clarke (1957) this mixing brings back into the surface waters the "vital" nutrients which are necessary for both plant and animal life.

The July-August maximum contained the greatest number of species found during the sampling period. Grice (1956) and Woodmansee (1958) also found that the greatest numbers of copepods occurred in the summer. The total copepod population dropped off in early September. This decrease in the copepod population at this

TABLE 1

Relative percentages of the three orders of free-living copepods found in the Mississippi Sound.

| ORDER | PERCENTAGE |
|---------------------|------------|
| Calanoida | 81.0 |
| Cyclopoida | 14.0 |
| Harpacticoida | 5.0 |

time may have been due to an overcrowding effect caused by the large number of zooplankton which used up the available food supply. The fall copepod maximum occurred in October (Figure 2 and Table 2) following a large phytoplankton "bloom" in September. During October only the two surface tows were completed, thus the total number of copepods present at that time may have been greater or smaller than is shown in Figure 2 and Table 2.

A gradual decrease in the number of copepods was noted through December with minimum numbers occurring in the January, 1966, sample. Grice (1956) and Woodmansee (1958) also found that the copepod population was lower during the winter.

The minimum numbers of copepods per m³ collected in January 1966, may be attributed to the extremely low temperature of 4.2°C recorded for the January 1966 sampling date. Following the January minimum the monthly catches increased. The February and March 1966 samples contained an abundance of ctenophores (*Mnemiopsis* sp.). These organisms were also present in the spring months of 1965, and may have been responsible for small numbers of copepods since they are active carnivores and may have been feeding on the copepod stock. According to Bigelow (1924) the ctenophores (*Pleurobranchia* and *Beroe*) are known to feed on small copepods and other small crustaceans. In addition, during the month of May 1965, there was an abundance of other zooplankters not frequently observed in the preceding four months. Immature stages of the following groups of animals were noted: Annelida, Cirripedia, decapods, Echinodermata and Tunicata. These larval forms could have a definite effect on the copepod population since they are in direct competition with copepods for food. Larval fish and arrow worms were also numerous. These organisms feed extensively on copepods and other small crustaceans according to Bigelow (1924) who stated, "It is probable that the comparative scarcity of copepods, often remarked at the precise levels, localities, or times when *Sagitta* abound, is direct evidence of the extent to which the latter may reduce the stock of their prey."

In summary, the competition and predatory habits of arrow worms, small fishes, and possibly ctenophores may be responsible for the smaller copepod populations found during the spring of 1965

LIST OF SPECIES

CALANOIDA

Family Calanidae

Genus *Eucalanus* Dana

Eucalanus pileatus Giesbrecht

Family Paracalanidae

Genus *Paracalanus* Boeck

Paracalanus parvus (Claus)

Family Centropagidae

Genus *Centropages* Krøyer

Centropages furcatus (Dana)

Centropages hamatus (Lilljeborg)

Family Temoridae

Genus *Temora* Baird

Temora stylifera (Dana)

Temora longicornis (Muller)

Family Pontellidae

Genus *Labidocera* Lubbock

Labidocera aestiva Wheeler

Labidocera species

Family Acartiidae

Genus *Acartia* Dana

Acartia tonsa Dana

CYCLOPOIDA

Family Oithonidae

Genus *Oithona* Baird

Oithona brevicornis Giesbrecht

Oithona species

Family Oncaeidae

Genus *Oncaea* Philippi

Oncaea venusta Philippi

Family Corycaeidae

Genus *Corycaeus* Dana

Corycaeus species

Genus *Sappharina* Thompson

Sappharina nigromaculata Claus

TABLE 2

Table showing total number of adult copepods counted, cubic meters of water filtered and average number of copepods per cubic meter of water.

| DATE | TOTAL NUMBER OF COPEPODS | M ³ OF WATER FILTERED | COPEPODS/M ³ |
|-------|-----------------------------|-------------------------------------|-------------------------|
| Jan. | 729 | 13 | 56 |
| Feb. | 843 | 43 | 20 |
| March | | | |
| April | 2,968 | 28 | 106 |
| May | 1,922 | 23 | 83 |
| June | 4,110 | 23 | 178 |
| July | 11,940 | 31 | 385 |
| Aug. | 7,555 | 24 | 314 |
| Sept. | 1,155 | 22 | 53 |
| Oct. | 1,812 | 11 | 165 |
| Nov. | 3,783 | 38 | 100 |
| Dec. | 123 | 51 | 2 |
| Jan. | 4 | | |
| Feb. | 467 | 14 | 33 |
| March | 858 | 34 | 25 |

HARPACTICOIDA

Family Tachydiidae

Genus *Euterpina* Norman*Euterpina acutifrons* Dana

SYSTEMATIC ACCOUNT OF THE SPECIES

Family Calanidae

Genus *Eucalanus* Dana*Eucalanus pileatus* Giesbrecht

Eucalanus pileatus was essentially a member of the summer fauna although it was found in February and November of 1965 in reduced numbers (Table 3). The maximum number of *E. pileatus* occurred in August, 1965, and the minimum number occurred in February, 1965.

TABLE 3
Monthly occurrence of copepods collected in the Mississippi Sound.

| | <i>Eucalanus pileatus</i> | <i>Paracalanus parvus</i> | <i>Centropages hamatus</i> | <i>Centropages furcatus</i> | <i>Temora stylifera</i> | <i>Temora longicornis</i> | <i>Labidocera aestiva</i> | <i>Labidocera</i> species | <i>Acartia tonsa</i> | <i>Oithona brevicornis</i> | <i>Oithona</i> species | <i>Oncaea venusta</i> | <i>Corycaeus</i> species | <i>Sappharina nigromaculata</i> | <i>Euterpina acutifrons</i> |
|----------|---------------------------|---------------------------|----------------------------|-----------------------------|-------------------------|---------------------------|---------------------------|---------------------------|----------------------|----------------------------|------------------------|-----------------------|--------------------------|---------------------------------|-----------------------------|
| Jan. '65 | | | | | | | | 360 | 369 | | | | | | |
| Feb. | 3* | | | | | | | 504 | 329 | | 1* | | | 3* | 3* |
| March | | | | | | | | | | | | | | | |
| April | | 1,110 | | | | | 46 | | 897 | 915 | | | | | |
| May | | 994 | | | | | 30 | | 3* | 895 | | | | | |
| June | 585 | 189 | | 570 | | 3* | 282 | | 165 | 543 | | 15* | 321 | | 1,437 |
| July | 815 | 534 | | 315 | | | 8,856 | 15 | 72 | 825 | 24 | 270 | 26 | | 48 |
| Aug. | 2,142 | | | 1,143 | 57 | 2,310 | 876 | | 23 | 198 | | 69 | 678 | 6 | 48 |
| Sept. | 6 | 69 | | 30 | | 180 | 261 | 195 | 258 | 147 | | | 3 | | 6 |
| Oct. | | 174 | | 3* | | 15 | 24 | 186 | 1,287 | 123 | | | | | |
| Nov. | 9 | 279 | 327 | 27 | | 138 | 3* | 3* | 3,409 | 324 | | | | | 264 |
| Dec. | | | 42 | 9 | | | | | 63 | 3* | | | | | 6 |
| Jan. '66 | | | | | | | | | 4 | | | | | | |
| Feb. | | | 3* | | | | | | 465 | | | | | | |
| March | | 27* | | 10 | | 19 | | 171 | 538 | 93 | | | | | |

Bold face numerals — maximum. * — minimum.

Family Paracalanidae
Genus *Paracalanus* Boeck
Paracalanus parvus (Claus)

Paracalanus parvus was found from April through December, 1965. It was not recorded again until March 1966 (Table 3). *P. parvus* reached a peak population in April 1965, and then decreased in numbers to reach a minimum in September 1965.

Family Centropagidae
Genus *Centropages* Krøyer
Centropages hamatus (Lilljeborg)

This calanoid copepod was one of the characteristic members of the copepod population during the winter (Table 3). It was found in November and December 1965, and again in February 1966. An unusually low temperature of 4.2°C recorded for January 1966 may have been responsible for its absence in January.

Centropages furcatus (Dana)

During the period of this investigation *Centropages furcatus* was taken from June 1965 through December 1965 (Table 3). It then disappeared and was not taken again until March 1966. The low temperatures recorded in the winter accounts for the absence of *C. furcatus* through the winter.

Family Temoridae
Genus *Temora* Baird
Temora styliфера (Dana)

Temora styliфера was only collected in August, 1965 (Table 3). It only accounted for about 1% of the total August copepod population. It is suspected that this species occurs more frequently outside the barrier islands.

Temora longicornis (Muller)

Temora longicornis is a member of the spring and summer copepod population found in the Mississippi Sound (Table 3). It was found from June 1965 to November 1965. It disappeared in December and was not recorded again until March 1966.

Family Pontellidae
Genus *Labidocera* Lubbock
Labidocera aestiva Wheeler

Labidocera aestiva was one of the largest copepods collected in the Mississippi Sound. Numerically, this calanoid copepod formed about 74% of the total copepod population found in July 1965.

This calanoid was collected from April 1965 to November 1965 (Table 3). Fleminger (1956) found *L. aestiva* to be the most abundant species of Pontellidae in the Gulf of Mexico. He found that this

calanoid was confined almost exclusively to the northern neritic waters of the Gulf between Florida and Laguna Madre, Texas. Numerically, this species was highly concentrated between Apalachicola Bay, Florida, and the east Texas coast. This could account for the fact that in this study *L. aestiva* was the dominant copepod in July.

Labidocera species

Labidocera sp. occurred sporadically throughout the sampling period (Table 3). It reached a maximum in February 1965, disappeared in the spring and was found again in the late summer and fall, then was not found again until March 1966. At no time during the 15 month sampling period did it account for any significant portion of the total copepod population.

Family Acartiidae

Genus *Acartia* Dana

Acartia tonsa Dana

Acartia tonsa was one of the characteristic members of the copepod population in Mississippi Sound, individuals of this species being taken the year around (Table 3). It was the second most abundant species.

Catches of *A. tonsa* during the winter months were generally higher than in the summer months. In May, *A. tonsa*, like most other year round species, exhibited a marked numerical decrease, apparently as a result of predation. During the summer months, *A. tonsa* was found only in small numbers. This species reached maximum concentrations in November 1965.

Family Oithonidae

Genus *Oithona* Baird

Oithona brevicornis Giesbrecht

Oithona brevicornis was the most abundant cyclopoid taken during this study. It was found from April 1965 through December 1966 (Table 3). By January 1966, it had disappeared but was found again in March of that year.

The maximum number of *O. brevicornis* occurred in the spring of 1965. From June until December, the numbers steadily decreased until January, when they were completely missing from the total copepod population.

Oithona species

In February 1965 and in July 1965 a copepod was collected which identified only to genus (Table 3). It very closely resembled *Oithona similis*, but there was only one adult individual collected in February and one adult collected in July. It was felt that this was insufficient material to make a positive identification and thus name a new species for this area, although it is possible that *O. similis* could occur in this region.

Family Oncaeidae
Genus *Oncaea* Philippi
Oncaea venusta Philippi

Oncaea venusta was a member of the summer fauna of Mississippi Sound. It was only found in June, July and August (Table 3). At no time did *O. venusta* account for any significant portion of the total copepod population.

Family Corycaeidae
Genus *Corycaeus* Dana
Corycaeus species

Corycaeus sp. was essentially a member of the summer fauna (Table 3). It was found consistently from June through September. Three individuals were found in February 1965 sample and it is possible that these were strays which came in from the waters outside the barrier islands.

Genus *Sappharina* Thompson
Sappharina nigromaculata Claus

Sappharina nigromaculata was recorded in the August sample, when six individuals were taken (Table 3). It is thought that this cyclopoid was also a stray from the waters outside the barrier islands. A. G. Fish states that *S. nigromaculata* occurs in large numbers outside the barrier islands in the Gulf of Mexico (personal communication with A. G. Fish).

Family Tachydiidae
Genus *Euterpina* Norman
Euterpina acutifrons Dana

This was the only species of harpacticoid copepods encountered during this investigation. It was found sporadically during the winter, summer and fall of 1965 (Table 3). This harpacticoid reached a maximum concentration in June. From June through the summer it steadily decreased in numbers until it completely disappeared in January, 1966. After that time, *E. acutifrons* was not encountered again.

Grice (1956) found *E. acutifrons* to be a year around member of the copepod population of Alligator Harbor. He found that the maximum numbers of *E. acutifrons* occurred during the spring and summer.

Each month that this species was collected ovigerous females were found, indicating that possibly *E. acutifrons* breed the year around in the Mississippi Sound.

Sutcliffe (1950) found *E. acutifrons* during most of the year, but it was present "in greatest numbers at higher temperatures" at Beaufort, N. C. Davis (1949) recorded it as the most common harpacticoid copepod in the collections he examined from the Florida coasts, while King (1949) reported it from many localities along the west coast of Florida.

SUMMARY

Monthly quantitative zooplankton collections were made in Mississippi Sound from January 1965 to March 1966.

Thirteen species of copepods were assigned to eleven genera. The numerical abundance and seasonal occurrence of all species were traced and these findings were compared when possible with similar studies on the west coast of Florida. Only one species, *Acartia tonsa*, occurred the year around.

The greatest number of copepods occurred in summer and the smallest in winter. The average number over the entire period of study was approximately 115 copepods per m³.

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A Commensal Relationship Between a Foraminifer and a Bivalve Mollusk

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A Commensal Relationship Between a Foraminifer and a Bivalve Mollusk¹

by

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During June, 1960, the M/V *Hermes* of the Gulf Coast Research Laboratory made several trawl hauls south of Horn Island, Mississippi. One haul was made June 27 at a depth of 20 m. on sandy mud bottom at 30°04'30" N., 88°36' W., or about 10 nautical miles south of Horn Island. A considerable number of animals, including starfish, hermit crabs and tube worms, were caught in the trawl. Pieces of the parchment-like worm tube of *Chaetopterus variopedatus* (Renier) were caught in the meshes of the net and were also collected.

A small bivalve mollusk, *Notocorbula operculata* (Philippi 1848) was found to be attached to most of the *Chaetopterus* tubes. Microscopic examination showed that the bivalves were attached at the anterior ventral margin with a byssal thread. This little clam has been found under similar conditions at Dry Tortugas, Florida (Harvey R. Bullis, Jr., personal communication). It has been reported as abundant in 22-65 m. of water on mud bottom along the entire northern coast of the Gulf of Mexico (Parker 1960). It was also noticed that a single species of Foraminifera was attached to many of the clams. The attachment was not very strong, seeming to consist merely of a weak cement holding the ventral surface of the foraminifer to the bivalve shell, nor was it confined to a particular area on the bivalve, but occurred in any position on either valve (see Figs. 1, 3, 4).

The Foraminifera was identified as *Hanzawaia strattoni* (Applin 1925). This species was reported by Applin (1925) from the upper Miocene in wells from coastal areas of Texas and Louisiana. Since then it has been reported from the Recent of the northern coast of the Gulf of Mexico by several workers (Bandy, 1954, 1956, Langford, 1959, Parker, 1954, Phleger, 1954, Phleger & Parker, 1951, and Parker, Phleger & Peirson, 1953). All reported it as an "Open Gulf" species with abundant occurrences at 12 to 100 m., lesser occurrences at less than 12 m. and from 100 to 250 m., and rare occurrences at depths greater than 250 m., although the latter may be due to displacement.

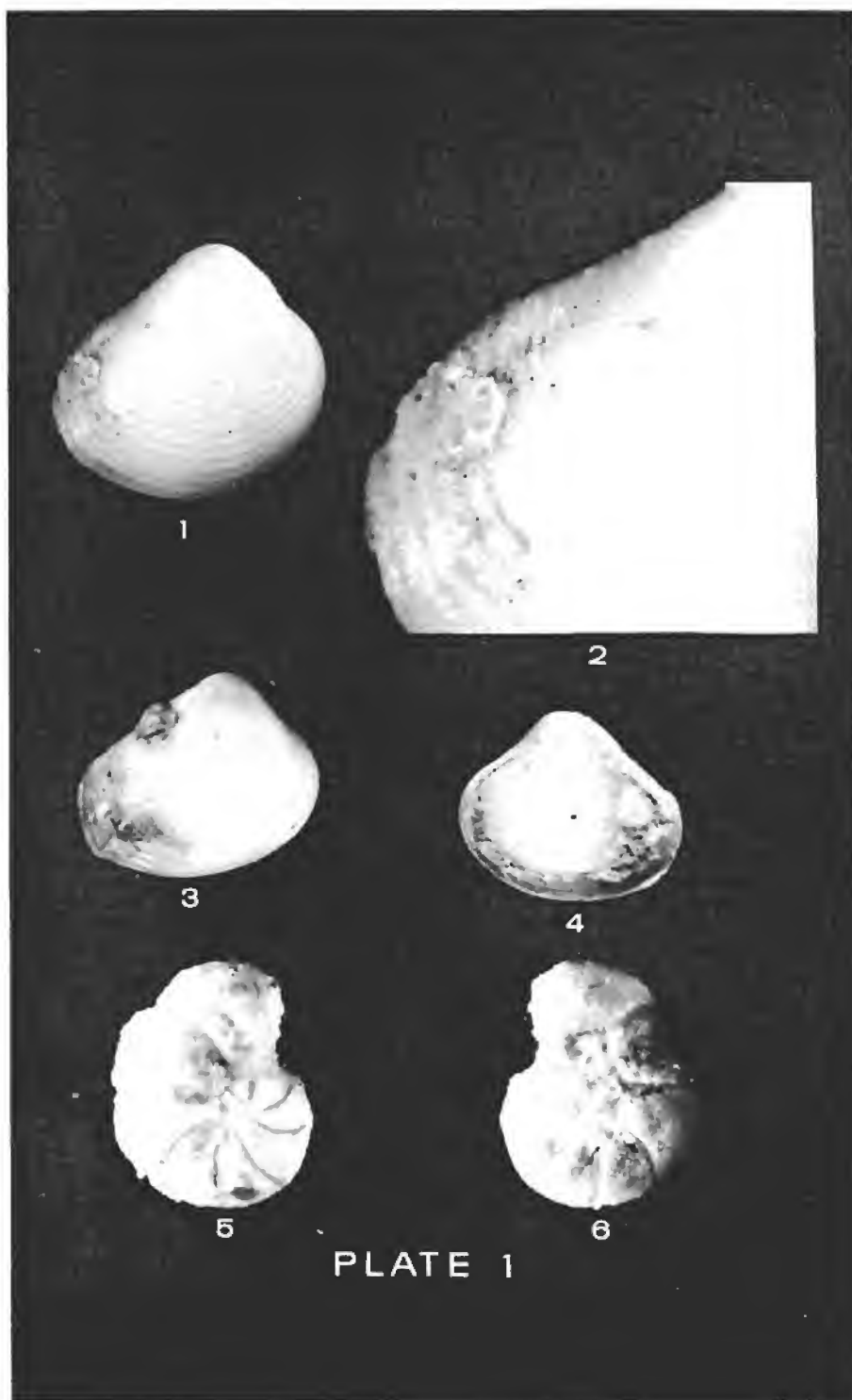
¹ Contribution No. 926 from the Institute of Marine Science, University of Miami.

Most Foraminifera are motile, but some are securely attached to the substrate. Genera such as *Sagenina*, *Tolypammina*, *Hospitella*, *Textularoides*, *Homotrema* and *Mineacina* all are securely attached to mollusk shells, echinoderm tests, rocks, other Foraminifera tests, corals or other hard objects on the sea floor. Specimens of these genera are usually broken if they are removed from their place of attachment. *Hanzawaia strattoni*, however, is loosely attached and specimens may be removed intact, suggesting that this foraminifer may have the ability to break its attachment and change its position, as *Sorites marginalis* (Lamarck) and *Planorbulina acervalis* Brady, two species found attached to blades of the sea grass *Thalassia testudinum* Konig, are able to do.

It is interesting that both mollusk, *Notocorbula operculata*, and foraminifer, *Hanzawaia strattoni* had climbed above the bottom at the Mississippi locality. A considerable load of fine sediment is carried by the water in this area and quantities of sediment must accumulate on the bottom during calm summer months. Animals that feed on very small organisms have their feeding processes disrupted when the load of fine sediment becomes too great at the sea-bottom interface. Such animals must move or perish under these conditions. Both the mollusk and the protozoan, in this case, solved their dilemma by climbing above the flocculent layer close to the bottom. Another possibility is, of course, that *H. strattoni* was merely using the bivalve as a substrate. However, the bottom centimeter or two would be just as unfavorable an environment for the foraminifer as for a bivalve mollusk (Langford 1959, Murray 1963).

In this case *H. strattoni* apparently gained all the advantage from the association between the two animals, using the bivalve as a means of elevating itself above the silt laden sediment-water interface. It appears to be a true commensal relationship for *H. strattoni* attached itself only to specimens of *N. operculata* and to no other bivalve present. Also in the "Open Gulf" fauna reported by Phleger (1954) south of Horn Island, there are several other species of Foraminifera capable of attachment, but none of these were observed on *N. operculata*. There may also have been some competition for food between mollusk and foraminifer. However, in no way could *H. strattoni* be called a parasite, for there was no absorption of shell material or holes penetrating into the mantle cavity at the points of attachment on *N. operculata* such as those reported by Todd (1965) made by *Rosalina carnivora* Todd on *Lima (Acesta) angolensis* Adam & Knudsen. *N. operculata* was in no way damaged. Another little clam with habits similar to that of *Notocorbula operculata* has recently been reported on by Harry (1966). He states that about half of the live specimens of *Crassinella lunulata* (Conrad, 1834) from off False Cape, Florida, had one or two live Foraminifera attached to the posterior ventral part of the shell. However, he did not attempt to identify any of this material, so it is not known if *Hanzawaia strattoni* was the species involved.

The association of living Foraminifera with algae or with sea grass has often been reported in the literature (Cushman, 1920, 1921, 1922, 1941).



SYNONYMY

NOTOCORBULA Iredale, 1930

NOTOCORBULA OPERCULATA (Philippi, 1848)

(Plate 1, Figs. 1, 3, 4)

Corbula operculata Philippi, 1848, Zeitschr. fur Malakozool., 13.

Varicorbula operculata Abbott, 1954, American Seashells, p. 456.

Notocorbula operculata Warmke & Abbott, 1961, Caribbean Seashells, p. 207, fig. 31h.

HANZAWAIA Asano, 1944

HANZAWAIA STRATTONI (Applin, 1925)

(Plate 1, Figs. 2, 5, 6)

Truncatulina americana Cushman, var. *strattoni* Applin, 1925, in: Applin, Ellisor & Kniker, Amer. Assoc. Petrol. Geol. Bull., 9, no. 1, p. 99, pl. 3, fig. 3.

Cibicides concentricus Phleger & Parker, 1951, Geol. Soc. America, Mem. 46, pt. 2, p. 29, pl. 15, figs. 14a, b, 15a, b.

Cibicidina strattoni Parker, 1954, Bull. Mus. Comp. Zool., 11, no. 10, p. 544, pl. 13, figs. 8, 11.

Hanzawaia strattoni Bandy, 1954, U. S. Geol. Surv. Prof. Paper 254-F, pl. 31, fig. 4.

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EXPLANATION OF PLATE I

- Fig. 1. *Hanzawaia strattoni* (Applin) attached to posterior dorsal margin of *Notocorbula operculata* (Philippi). x 8.4.
- Fig. 2. Close-up of posterior dorsal margin of the specimen of *Notocorbula operculata* shown in Fig. 1 x 21.
- Fig. 3. *Hanzawaia strattoni* attached to the dorsal margin of a specimen of *Notocorbula operculata*. x 8.4.
- Fig. 4. *Hanzawaia strattoni* attached to *Notocorbula operculata* near the posterior dorsal margin. x 8.4.
- Figs. 5, 6. *Hanzawaia strattoni* (Applin). Specimen removed from the posterior dorsal margin of *Notocorbula operculata*. Fig. 5. Dorsal view. Fig. 6. Ventral view. x 38.

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Observations on the Stone Crab, *Menippe mercenaria* Say, In the Vicinity of Port Aransas, Texas

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Observations on the Stone Crab

Menippe mercenaria Say,

In the Vicinity of Port Aransas, Texas

by

Earnest H. Powell, Jr. and Gordon Gunter
Gulf Coast Research Laboratory

INTRODUCTION

Observations on the stone crab, *Menippe mercenaria* Say, were started on December 16, 1947. The purpose of these observations was to study the natural history and behavior of this crab, with special reference to its importance as an oyster predator. Plans called for some simple laboratory experimentation and monthly field observations. Although the regularity of the observations was interrupted for various reasons, some information gained which may interest workers is herewith presented.

GENERAL INFORMATION

Distribution

Although the Cuban stone crab, *M. nodifrons* Stimpson, has been reported from Indian River, Florida, and from Cameron, Louisiana (Rathbun 1930), *M. mercenaria* is the only one common on the South Atlantic and Gulf Coasts and is the only *Menippe* recorded in Texas waters. Its range is from North Carolina to Mexico. Although not abundant at any point, it has been taken in commercial quantities in Southern Florida for many years and was caught and sold to Port Aransas restaurants thirty to forty years ago. Florida still produces about a million pounds of stone crab meat a year (see Johnson 1967). Although a few stone crabs taken commercially in Florida were caught by hand in former years, most were taken in traps set for the marine crawfish (*Panulirus*), but unlike the crawfish, were consumed locally.

To date, no distribution study of this crab on the Texas coast has been made. On the South Texas coast the crab has been found in abundance only on the mud flats of Harbor Island between Aransas Pass and Port Aransas, on the mud flats behind Mathew's wharf, along the breakwaters near Rockport and along the south jetty on Mustang Island. Dr. Joel W. Hedpeth and the second author saw a colony on the mud flats in Mesquite Bay just inside of Cedar Bayou Pass. Fishermen report the crab from deep waters of the Gulf of Mexico in the vicinity of wrecks.

Although the distribution of stone crabs is highly localized, they have been taken in South Texas from every type of bottom, (rocks,

sand, shell, clay, and mud). Apparently the crabs prefer the vicinity of oyster reefs or the rocks along jetties, which are artificial, or the offshore reef areas.

Whitten, Rosene, and Hedgpeth (1950) have recorded distributions of this crab along the jetties of Texas passes. Gunter (1950) recorded specimens from the area under study and from Copano Bay at a salinity of 11.6 parts per thousand, the lowest known where the stone crab has been collected.

Measurement Ratios

All specimens examined came from inside Aransas Pass, that is the bay area of South Texas. In the small and large specimens of both sexes examined, the length of the carapace was 1.3 times the width. In virtually every case, the width of the major chela times 2.8 equaled the width of the carapace. This ratio was useful in determining the size of a crab which had lost a major cheliped. There was a proportional increase in length of the major and minor chela, but this increase was not proportional to increases in the dimensions of the carapace. The ratio between the width of the major chela and the width of carapace probably exists only when the major chela has never been lost.

In proportion to the width of carapace, the frontal width of immature specimens is much greater than in large specimens. Possibly this can be used as an index to the ages of individuals.

THE MUD FLAT HABITAT

Distribution

In some places on the mud flat, stone crabs are apparently colonial and an isolated hole is rarely found and the holes are generally beneath dense clumps of oysters. Stone crab burrows are not readily found. Their concentration seems heaviest where there are scattered clumps of oysters. In some places holes are confined to areas no more than 25 meters square with a few scattered outside of the area of dense population. Within these areas individual holes are at times no more than 20 cm. to 30 cm. apart.

On other parts of the mud flats, holes are scattered over decidedly more extensive areas, much farther apart, and more or less evenly spaced. The reasons for this variance in concentration has not been discovered.

Mounds and Holes

Usually there is a conical depression at the entrance of a stone crab burrow, where the crab often rests. The hole is ordinarily marked by a mound of mud and debris around and about, which is brought to the surface when the burrow is dug. When freshly removed material is present, there is usually a runway. Stone crab burrows in the Port Aransas area have not been observed with bits of freshly broken oyster shell about the entrance. Efforts in the field to recover

bits of broken oyster shell similar to pieces of shell broken by stone crabs in the laboratory have been unsuccessful.

On the other hand, Gunter and Hedgpeth have reported verbally that stone crabs on mud flats in Mesquite Bay almost invariably have cracked oyster shell around the margins of their holes. According to Menzel and Hopkins (1955, Fig. 7) the same is true in Louisiana.

Neither the size of a stone crab hole nor the size of the mound is indicative of the size of the crab within the hole or the burrow. Of ten measured holes and mounds, the smallest hole (45 cm. x 35 cm.) contained the largest crab (111.4 mm.). A 90.3 mm. wide stone crab was taken from a hole measuring 91 cm. x 61 cm. The mound around the second hole (206 cm. x 33 cm. x 9.2 cm.) had almost three times the cubic content of the first (162 cm. x 18 cm. x 6 cm.). Presumably, much of the mound around the first hole was washed away by the tide, an action which would not only decrease the size of the mound, but also the size of the hole. Further observations indicated that no relationship existed between the size of the stone crab hole, the mound, and the crab itself.

Burrows

Small stone crabs apparently do not dig burrows, but simply conceal themselves in crevices of rock or shell, or beneath rocks or shell. Large crabs may do the same thing under stress. A large crab running from the second author went to a clump of oysters, lifted it up, crawled under and let it down again and was as well concealed as if it had lowered a trap door over itself.

The smallest crab (43.2 mm.) found in a true burrow had hollowed out a spot approximately three times the depth of its body beneath a rock. The burrow went only far enough beneath the rock to conceal the crab from directly above or behind. The burrow had no hole, but at its entrance was a round mound (13 cm. x 13 cm.) of shell fragments (on a shelly bottom) and debris. The crab lay sideways in the burrow with the minor chela toward the entrance. There was a smaller stone crab beneath the same rock, but not within the burrow. All rocks on this coast are artificial, and are found only around jetties and where ballast was dumped by sailing ships. The "worm rock" of the Laguna Madre is in a different category.

All stone crabs observed between 44 mm. and 73 mm. wide had burrows going straight down for 25 cm. to 60 cm. Here they leveled off, or might rise or fall, and make several turns. In all cases, burrows of this type ended blindly with no chamber and with the crab sideways at the end of the passage with the minor chela toward the entrance.

All crabs which measured 75 mm. wide or more which were taken from burrows had the kind described by Rathbun (1930) as typical: it extends horizontally or obliquely from one bank of the hole. In burrows of this sort, the crab has a chamber at the end of the passage where it lies facing the entrance. Burrows of this type containing 90 mm. or larger crabs varied in depth from approximately 20 cm. to 75 cm.

Commensal Organisms

Organisms from the Burrow — On January 8, 1948, the following animals were taken from a stone crab hole: 60 mud crabs, *Eurypanopeus depressus* and/or *Panopeus* sp., ranging in size from 3.1 to 17.1 mm., one grapsoid crab, *Pachygrapsus transversus*, 17 hermit crabs, *Clibinarius vittatus*, 9 grass shrimp, *Palaemonetes vulgaris*, 2 mussels, *Brachidontes recurvus*, one scallop, *Pecten* sp., an unidentified nereid worm and five gobies, *Gobiosoma* sp. and *Gobionellus* sp. There were one or more uncollected pistol shrimp, *Crangon* sp. within the hole. There was a clump of oysters in the hole.

On February 7, the burrow of another stone crab was explored in the same manner. The burrow contained approximately 300 oysters in two clumps. None of the oysters were longer than 70 mm. In addition the burrow contained 52 mud crabs from 3.0 to 23.4 mm. wide, three pistol shrimp (one collected — 48.6 mm.; others escaped to burrows outside of hole). Twenty-four grass shrimp from 20 to 32 mm. long, 3 hermit crabs, two conchs, *Thais haemastoma*, (11.8 mm. and 9.7 mm.), and a few scattered acorn barnacles and mussels, 5 unidentified clams, an unidentified sea anemone, and many small amphipods and gastropods. The tube worm, *Eupamotus dianthus*, was numerous in the hole and throughout the area.

Subsequent checks showed that the toad fish or oyster dog, *Opsanus beta*, and the striped killifish, *Cyprinodon variegatus*, are also found in and around stone crab burrows. That these and other organisms should be found in stone crab burrows is not surprising, as they often contain the only water left on the mud flat at low tide. For this reason stone crabs exert a very strong ecological influence, especially in areas of extensive flats exposed by low tides frequently and periodically. Their homes are the last refuges of many small and weakly motile animals that could not reinvade the flats again quickly or easily, between tides. In short, were it not for the stone crabs the life complex of the shallow flats would be considerably different from what it is.

Organisms from the Crab — In this area, stone crabs are rarely found with external calcareous growths. A tube worm was found on the merus (wrist) of the minor cheliped of a stone crab taken on the mud flats January 30. In the latter part of August, a female specimen from the south jetty was taken with a very small acorn barnacle, *Chelonibia patula*, in the median sulcus. It is well known that this barnacle only settles upon living organisms and is chiefly an associate of turtles. This barnacle disappeared before the first of October. Probably stone crabs remove the calcareous organisms that strike on their bodies.

NATURAL HISTORY

Numbers and Sizes of Specimens Recorded

Efforts were made to collect, examine and measure 100 stone crabs a month, but it was found that between January and June the tide was too high to permit collection of a significant number of crabs. The following table is based on those individuals taken from the south jetty of Mustang Island only:

TABLE I

Measurements in millimeters of stone crabs taken from the south jetty (Mustang Island) of Aransas Pass.
(1947-48)

| | December | January | June | July | August |
|--------------------------|----------------|----------------|----------------|----------------|----------------|
| Number | 10 | 45 | 71 | 73 | 95 |
| Range, Width of Carapace | 9.8 to 17.1 | 5.5 to 49.0 | 4.2 to 74.6 | 3.9 to 80.0 | 4.8 to 62.4 |
| Mean Width of Carapace | 12.32 | 22.53 | 24.97 | 29.95 | 24.74 |

In January, seven collecting trips were made along the jetty to obtain the 45 specimens measured, their collection requiring diligent search. Four trips were required to collect the 71 individuals measured in June, 3 trips for the 73 in July, and 2 trips to collect the 95 measured in August.

One out of every 4.7 individuals examined during the December-January period measured 12 mm. or less across the carapace; for the May-June period, one out of 8.9 individuals; and for the July-August period, one out of 6.5 individuals. Except in January, one or more 5 mm. wide individuals were recorded each month.

These data would indicate that the number and sizes of stone crabs increased from January to July, and that the number continued to increase through August. Since there was a significant change in the ratio of males to females (from 5.0 to 1 to 2.65 to 1, see following section) it appears that there was an apparent influx of small females to the jetty area. The finding of very small individuals throughout the study period but only one berried female would indicate that the stone crab breeds over a long season, but outside of the area of study.

Breeding

Of 92 female stone crabs examined only one, a 33.8 mm. specimen, taken August 1, was berried. A 107.9 mm. crab taken on the mud flats July 23 extruded eggs in the laboratory in mid-August.

Sex Ratio

The ratio of males to females of specimens for the December-January period on the basis of 61 individuals was 4.28 to 1; for the May-June period on the basis of 160 individuals, 5.00 to 1; and for the July-August period on the basis of 175 individuals, 2.65 to 1. The sex ratio on the mud flats from May through July was 5.2 males to 1 female. No survey was made of the mudflats in August.

FIELD BEHAVIOR

Activities in the Field

It is generally believed that stone crabs are nocturnal, but individuals have been observed abroad throughout the day and night. Surveys of stone crab holes made on the mud flats showed that ap-

proximately the same number of crabs were in their burrows or holes around midnight as during the daylight hours. A field trip made to the flats on February 7 on an extremely foggy morning revealed that fewer crabs were in their holes or burrows than ever observed before or since. Although crabs kept in the laboratory have been more active at night than in the day, these observations might indicate that the crab is crepuscular rather than nocturnal.

Apparently stone crabs prefer to rest in their holes near the surface rather than deep in their burrows. Day and night they have been observed lying sideways in their holes at the entrance of the burrow always with the minor chela outermost.

Eyesight — Although an observer is often able to see a crab in its hole from a distance without being noticed, even the stealthiest movements near the crab are detected. Probably little vibration is transmitted through the soft silt and mud of the flats, and as ripples do not reach the crab when the banks of its hole protrude above the water level, the crab probably has a keen sense of vision. Seemingly cautious movements at night by flashlight or gasoline lantern are no more readily detected by stone crabs than are comparable movements by daylight.

Defense Patterns

As the observer nears the crab hole, the crab will crouch momentarily in an apparent effort to hide. If the observer continues his approach, the crab retreats slowly out of sight into the entrance of the burrow. When the hand is placed in the hole, the crab pushes it away with a quick lateral motion of the cheliped and retreats about half way down the burrow. If the hand is thrust after the crab, it will again push the hand away and retreat to the chamber at the end of the burrow. Here it digs its legs into the mud and presses its body and chelipeds against the walls of the chamber. No further effort to push the hand away is made. If the hand is withdrawn from the burrow, the crab will follow up the passageway shoving the hand ahead of it. If the hand is again thrust into the burrow, the crab will retreat once more to the chamber.

To capture a crab in its burrow, the hand should be run over the top of the carapace and hooked behind the crab. A firm, steady pull will then dislodge the crab. If the collector's grip on the crab is not firm, or if he hesitates or fumbles about in the burrow, the crab will often pinch the hand slightly. No effort to hold on is made and the hand can be withdrawn easily with little chance of injury.

A crab approached while abroad on the mud flats will crouch beneath the nearest clump of oysters or rocks with the chelae across the buccal cavity and make no attempt to move off unless touched. Then it will shove the hand away and move from the area so rapidly that it is often difficult to capture if there are obstacles in the neighborhood.

On the night of July 23, a crab was observed dragging an oyster across an open patch of mud. When this crab became aware of the observer's presence, it reared back, raised its chelipeds and brought them together several times with a loud click, while attempting to move off. This reaction is similar to a defense pattern of the blue

crab, and is peculiar to certain individual stone crabs. Only one other crab observed (in the laboratory) exhibited this reaction.

On January 30, immediately after a severe freeze, it was noticed that many of the crabs had plugged the entrance to their burrows with bits of debris and mud. This was near noon, and all crabs observed were in their holes sunning themselves. The plugs were still in place, but they had been forced down to make a passageway large enough for the crabs to ease in and out. As this phenomenon was not observed in warmer weather, it is assumed that the plugged burrow is a defense against cold weather rather than against attack.

As is the case with many crustaceans, the stone crab will readily autotomize its appendages to prevent capture. That is, if one grips one or more legs or a cheliped when the crab has a hold on a solid object, the crab will break off the members. Often a crab will autotomize a cheliped if it is caught by the body while gripping a heavy object. One crab was allowed to grip the edge of a small dip net by which it was picked up. The crab, instead of releasing its grip on the net, autotomized the cheliped. This is similar to a defense pattern of the ghost crab as described by Cowles (1908).

A stone crab, when gripping an object such as a stick or pencil, will not release its hold even if spun violently around. The fingers of the chela can not be pried apart, nor can the crab be readily removed from the object gripped. This grip is so strong that one large male (111.4 mm.) in the laboratory crushed its own chela and bled to death when it gripped a hard object in the tank. The hold is released gradually, and after the releasing motion is begun, the crab will not fully retighten the hold.

Large stone crabs are capable of inflicting sharp pain by digging their spurs (glabrous tips of the dactylus) into the hand upon capture, although they are incapable of drawing blood in this manner. This reaction may be an attempt to grip anything that might prevent capture. If attacked from the rear, the stone crab will often stab at or push away the offending object with the third and fourth legs.

Stone crabs, especially the small individuals, will often feign death upon capture. The ambulatory appendages are folded against the body and the open chela are extended as far beneath the body as possible so that much of the abdomen is protected. The chela are held one over the other (usually the minor chela on top) so that an object may be placed in both chelae at once. Rough handling will usually induce this reaction in very small crabs, but it is rare with larger (80 mm.) specimens. Possibly, this position is assumed to allow wave action to transport the crab from place to place, or it may be related to the "eierschutzreflex" of Bethe (1898).

The stone crab has an irregular patch of oblique ridges on the inner surfaces of both chela known as stridulating organs. In small specimens, these are rubbed vigorously across what appears to be the second and third teeth of the carapace to produce a sound not unlike that of the field cricket. Stridulation in larger specimens has been heard and seen only once (86.6 mm. female). In this case, it was much more erratic than in the younger specimens, the stridulating organ only occasionally striking the edge of the carapace. The sound pro-

duced is similar to that of a smooth file drawn across the ridge of a walnut shell. The purpose of this action has not been determined.

When away from their holes, large crabs have been seen to move their bodies in a slight lateral motion to cover the edges of the carapace with mud. Often small depressions are hollowed out in this manner, but the outline of the body is usually plainly discernible.

In the laboratory, the stone crab has been observed to exhibit the "Aufbaum" reflex when disturbed. The crab fully extends both open chelae and raises the body to a position almost perpendicular to the ambulatory appendages and the plane of support. The crab will follow a moving object with movements of its body almost to the point of falling over backwards. The position of its legs is rarely changed. A touch on the outer surface of the chela will cause a slight twisting motion of the body toward the offending object. A touch on the inner surface of the chela causes a quick hugging or clasping motion. At the completion of this movement, the crab returns to the original position with the chelipeds extended. This reaction does not take place unless the crab is actually touched.

Small stone crabs (20 mm. or less) will attack a moving object by lunging out and grasping the object between the merus and manus and pressing the tuberole of the merus against it. This reaction has not been observed in larger crabs. Whether this is a defense reaction or a method of food getting has not been determined.

Two stone crabs, excited by rough handling of their container, were observed fighting. One of the crabs caught the other's leg. The second crab was able to twist around and force the first to release its hold by prying with the major chela. Stone crabs will autotomize their legs if caught by another crab.

Regeneration and Growth

Although no data have been taken, field and laboratory observations indicate that, as is the case with most crabs, the period between moults increases as the crab becomes larger. The duration of the "soft" stage is much longer with a large crab than a smaller one.

The rate of regeneration of lost appendages is proportional to the periods between moults. That is, a small crab regenerates lost appendages much faster than a large one. Apparently, the ambulatory legs are fully regenerated at the first moult after their loss. At the first moult after the loss of a cheliped, the regenerated member is smaller in size than it would be had it not been lost but is functional. As several crabs have been collected with two minor chelipeds, it is assumed that after the loss of a major cheliped, a new minor cheliped is regenerated. Whether this regenerated minor cheliped is replaced by a major cheliped the second moult after its loss has not been determined. This is probable as the number of crabs collected with two minor chelipeds is very much less than those collected with either or both chelipeds missing.

FOOD HABITS

Field Observations

Material for all field experiments in the vicinity of Port Aransas was set out in wire baskets screened with one-fourth inch mesh

hardware cloth. Although hardware cloth does not completely prevent entrance of oyster predators, stone crab predation at Port Aransas was negligible except in May and June. When checks were made during these months, stone crabs were found in oyster baskets at three of four stations.

Although no record was kept of the number of stone crabs found at these stations between October 1947 and March 1948 it is virtually certain that these six baskets had not contained more than a half dozen crabs, all of them very small. No stone crabs were observed in the oyster baskets in April.

When the baskets were re-opened in May for a check of growth and mortality, 36 stone crabs ranging in width from 16.1 mm. to 61.6 mm., were found in the six baskets. From each of two of these stations, a basket of oysters was chosen for a study of stone crab predation. The results of this study are given in Table II. The figures are based on the total number of oysters dead, not on the total number of oysters in the baskets.

Boxes classified as untouched by stone crabs had no marks on them such as a stone crab would leave. Those marked, "*Martesia* removed, but not killed by crab," had one or more boring clams picked from the shell by the crabs but had their hinges intact and were without chips, cracks, or breaks along their valve edges which would affect perfect closure of the oyster. Death of these oysters was attributed to causes other than stone crab predation.

Boxes with sprung hinges, separated valves or chips or holes which would permit a stone crab to reach the oyster itself were considered stone crab mortality. All shells (unmatched valves) were considered deaths attributable to stone crab predation.

The probability that this is an over-estimate of the number of oysters killed by stone crabs should be pointed out. Dr. S. H. Hopkins (private conversation) stated that after eating oysters the stone crab often cracked the shells in order to reach shell parasites they contain. It is conceivable, then, that the crab would also crack the shells of dead oysters for the same purpose. A few of the shells classified as victims of stone crab predation were so small that it is probable that they came from spat attached to some of the oysters. Death of these could be attributed to the weight of the oyster or pressure from adjacent oysters preventing the spat from opening their shells. Boxes could have been broken apart in handling before the study was made.

It is possible that an influx of stone crabs from another area was responsible for the entire increase in mortality at these stations. This, however, is not probable as there were other stations in the immediate vicinity as accessible to entrance by stone crabs in which no crabs were found. It is more likely that the stone crabs entering the three stations were attracted by odor or some other stimulus emitted by dead or dying oysters.

It will be noticed that there was a very sharp increase in mortality attributable to stone crab predation at Station 1 between May 17 and June 24. Between these dates the top of the basket was lost which allowed stone crabs to enter and leave the basket at will. On June 24, no stone crabs were found in the basket, but it contained 7 living oysters all with one or more boring clams picked from their

TABLE II
STONE CRAB PREDATION ON OYSTERS AND MARTESIA
AT PORT ARANSAS

| | Station 1 5/17/48 | Station 2 5/17/48 | Station 1 6/24/48 | Station 2 6/24/48 |
|--|----------------------|----------------------|----------------------|----------------------|
| Number of boxes untouched by crab | 38 | 72 | 2 | 28 |
| Number of boxes with <i>Martesia</i> removed, but oysters not killed by crab | 95 | 38 | 15 | 1 |
| Number of boxes with sprung hinges or with chipped or separated valves | 27 | 6 | 13 | 3 |
| Shells | | | | |
| With <i>Martesia</i> removed | 0 | 2 | 1 | 0 |
| Without <i>Martesia</i> removed | 3 | 4 | 3 | 0 |
| Total mortality | 163 | 122 | 34 | 32 |
| Total deaths attributable to stone crab predation | 30 or 18.4% | 12 or 8.8% | 17 or 50% | 4 or 12.5% |

shells. A calculated 32.7% of the mortality on this date was due to the added accessibility of the oysters.

Laboratory Experimentation — The writers have detailed descriptions and tables of experiments concerning stone crabs eating oysters in the laboratory, which are too long to present but we shall attempt to adumbrate them here.

One 62 mm. female ate 15 oysters, ranging from 20 to 44.5 mm. in length between December 2 and March 23, a period of 111 days—or one oyster every 7.4 days.

Eleven crabs (24.5 to 48.8 mm. in width) were placed on 20 spat on February 6. Thirty-three spat were eaten in 50 days.

When a clump of oysters estimated to consist of 175 individuals from 15 mm. to 60 mm. in length was placed in the aquarium, the crabs killed one oyster per crab every 5.4 days until July 1. In May and June in this tank three crabs were apparently killed by their mates and eaten.

Other Foods — Since the stone crabs used in the experiments were provided only oysters as food the results of the experiments are not indicative of the number of oysters a stone crab will kill under natural conditions. In an effort to find other items of food taken by the stone crab in addition to oysters, one or more of which might serve as a control for laboratory determination of the rate of stone crab predation, a food preference experiment was set up. In this

experiment, oysters were used as the control item of food; i. e. oysters were always available to the crabs along with some other item or items of potential food. An effort was made to offer the crab all macro-organisms found in its mud flat habitat.

Superficial examination of the data and other observations indicate that the crab prefers acorn barnacles (*Balanus eburneus*) to any other items of food offered. Generally, small oysters and spat are eaten before large oysters. The stone crab seems to prefer natural or uncultured oysters to single or culled oysters. Because of the difficulty of weighing and evaluating the other items of food eaten by the crab in this and other experiments the data are presented in discussion form.

Conchs — On January 13, six stone crabs ranging in size from 13.5 mm. to 101.8 mm. were placed in an aquarium with 145 conchs, *Thais floridana*. On January 16, the crabs were removed from the aquarium and its contents examined. Twenty-eight conchs had chipped or cracked shells. A broken and partially eaten conch was removed from the maxillae of the largest crab.

February 6, twenty-four conchs were placed in an aquarium with two stone crabs measuring 84.1 mm. and 52.2 mm., the latter without the minor cheliped. February 23, 17 days later, 11 conchs were dead, 7 of them cracked and eaten by the crabs. The mean water temperature for this period was 11.6° C.

Conversely, a conch was observed eating a small crab in the laboratory. The proboscis was inserted above the *basis capituli* of the left cheliped. The crab had neither cheliped. As the crab was moribund when observed, it was assumed that the conch killed the crab.

Roughly, one out of five conchs collected from the south jetty at Port Aransas in mid-August had chipped or cracked shells similar to those attacked by the crab in the laboratory.

Flatworms — A series of stone crabs brought in for measurement and examination was placed in a tank containing several sea anemones and a large flatworm presumed to be *Stylochus ellipticus*. The following day the worm was gone from the tank, presumably eaten by a stone crab.

On May 15, a flatworm known to be *Stylochus ellipticus* was placed in a finger bowl containing a 16.2 mm. male stone crab and a series of five spat. Almost immediately the crab started across the bowl toward the worm. As the crab neared the worm, it feigned an attack on a piece of tar in the bowl, then pounced on the worm seizing it basket fashion with the ambulatory legs. The crab had difficulty retaining the worm which several times almost flowed from beneath the crab. Each time the fourth legs were brought to bear and escape prevented. Once, the crab was frightened away from the worm, but it returned immediately. Further attempts to frighten the crab away from the worm resulted in the crab retreating with the worm. The worm was dead and partially eaten 15 minutes after it was placed in the bowl.

The Boring Clam — Two lots of oysters, one from Copano Bay and the other from Tin Can Reef, were brought to the laboratory and deemed unsuited for physiological experimentation because of a

heavy infestation of the boring clam. These oysters were allotted to the writers for use in stone crab experimentation.

When the oysters were offered to stone crabs, clams were removed from many of them without injury to the oyster. In two instances after virtually all of the clams were removed, the shell was so thin that it was broken by hand.

The Mud Worm — A stone crab was observed attacking a mud worm, *Polydora websteri*, only once in the laboratory. This worm escaped the crab by autotomizing several caudal segments.

Jellyfish — On December 2, a small stone crab on the south jetty was seen eating a cabbage-head jellyfish, *Stomolophus meleagris* Agassiz, which had been stranded on the rocks by the tide. On June 29, a small cabbage-head was placed in an aquarium with an 86.6 mm. female and 76.4 mm. male stone crab. After the jellyfish died it was partly eaten.

Other Crabs — On December 16, a fragment of a grapsoid crab, presumably *Pachygrapsis transversus*, was removed from the mandibles of a stone crab collected on the mud flats behind Mathew's wharf. Since several of these crabs were found dead on the flat at this time, it is probable that the grapsoid crab was dead before the stone crab started to eat it.

On January 5, a stone crab hole on the mud flats of Harbor Island was explored. The burrow was not found, but a small blue crab, *Callinectes sapidus* Rathbun, with a freshly broken movable finger was collected. This crab was placed in a canvas bucket with two stone crabs (76.4 mm. and 80.0 mm.) where it sustained a similar injury of the other chela.

These three crabs were placed in a large tank on our lower dock. The following morning, the blue crab was dead and partially eaten by the stone crabs. Further efforts to provoke stone crabs into attacking a blue crab failed.

The hermit crab, *Clibinarius vittata*, was eaten by stone crabs in the laboratory several times. Field observations indicate that the stone crab or some other animal capable of breaking a shell occupied by a hermit crab often preys on hermit crabs.

Cannibalism — That stone crabs prey on one another in captivity has been shown many times. Whether this is the case in nature when food becomes scarce is unknown.

Diatoms — On many occasions, stone crabs were observed using their ambulatory legs to place bits of detritus from the bottoms of aquaria between their maxillipeds. Microscopic examination showed that this litter contained large numbers of diatoms. Frequent repetition of this act and the fact that the gut often contains vegetable matter suggests that diatoms and possibly other algae may constitute an item in the diet of the stone crab.

Barnacles — Laboratory experimentation tends to indicate that the acorn barnacle, *Balanus eburneus* Gould, is a favorite item in the diet of stone crabs.

Fish — Whether or not stone crabs kill and eat fish has not been determined.

Pistol Shrimp — Pistol shrimp would probably not be as plentiful in the neighborhood of stone crab holes if stone crabs preyed extensively upon them.

Carrion — In this area, it is not uncommon to take stone crabs on chunks of meat used as bait for blue crabs. This would indicate that stone crabs will feed on bottom refuse.

Mussels — The common mussel, *Brachidontes*, was often eaten by the stone crab from "natural" clumps of oysters.

DISCUSSION AND SUMMARY

The Mud Flat Habitat

In the vicinity of Port Aransas, stone crabs are somewhat gregarious. They seemingly prefer to inhabit areas in the immediate vicinity of oyster beds or the rocks along jetties. There is no particular relationship between the size of the stone crab hole, the size of the excavation mound, the depth of the burrow and the size of the crab itself. Almost invariably, stone crab holes in this area contain clumps of living oysters. Many animal forms are found in stone crab holes at low tide.

Natural History

Incomplete data indicate that the stone crab population increases from January through August. Apparently the peak of the breeding period comes before May, although immature individuals were recorded throughout the period of study. Scarcity of berried females indicated that ovulation probably occurs outside of the study area. The only berried female recorded, a 33.8 mm specimen, was taken August 1. As the ratio of males to females along the south jetty dropped significantly in July and August, but remained more or less constant on the mud flats, there must have been an influx of small females to the jetty area from a nearby area other than the mud flats. As there was a large population of males along the jetty and as the small females appeared to be sexually mature, this influx was possibly caused by a mating stimulus.

Field Behavior

Frequent observations of stone crabs abroad in the field both day and night, and the finding of many empty burrows on a very foggy morning indicate that the stone crab is probably crepuscular rather than nocturnal. The crab seems to prefer to rest in its hole rather than in its burrow. Usually, the crab will be found in its hole both day and night with the minor chela outermost.

Defense Patterns

Stone crabs exhibit many behavior patterns which have been observed in other crabs.

They will readily autotomize any or all appendages to prevent capture, or to stop excessive bleeding.

Ambulatory legs are sometimes folded around the body with open cheliped extended as far as possible beneath the body. As this position is more easily induced in female specimens, it may be the "eierschutzreflex" of Bethe, or it may be a position assumed to allow currents and wave action to transport the crab.

Stridulation has been observed in both small and large specimens.

Stone crabs will often place both chela before their face and make an apparent effort to duck behind them. When this position is assumed, the eyes are always extended.

Stone crabs will almost invariably push an intruder away rather than attack with the chela. A quick but powerful lateral motion of the cheliped is used.

The "Aufbaum" reflex is more common with large individuals. The crab raises its body to an almost perpendicular position and fully extends both open chelae.

Stone crabs, both in the field and in the laboratory, have been seen to raise the chelipeds and bring the chelae together several times with a loud snap at the approach of an intruder, a reflex common to the blue crab.

Plugging of burrows was observed only during a very cold spell.

Stone crabs often hug or clasp objects to them forcing the tubercle of the merus against the object in a manner which can be quite painful if a finger is seized.

Often a stone crab in a burrow or crevice of rock will press its body and chelipeds against the walls making it difficult to seize and remove the crab.

Ordinarily stone crabs adopt a passive means of defense. This is fortunate, as the crab is very strong and might easily remove a man's finger.

Stone crabs are able to conceal themselves quickly beneath objects or obstructions. They will often take advantage of the silt which collects on their carapace and dig small depressions for concealment on a mud bottom.

Stone crabs have a very strong influence on the life of sand and mud flats that go dry with wind or lunar tides, because their water-filled burrows are the final refuge of hundreds of small aquatic organisms that cannot withstand drying.

Food Habits

Indications are that the size of an oyster, while important, is not a valid index of vulnerability to stone crab predation. One of a series of stone crabs none larger than 16.0 mm. killed an oyster measuring 38.5 mm. x 25.3 mm.

Laboratory experiments indicate that unless most of the items in the diet of stone crabs are discovered, stone crab-oyster predator relationships cannot be adequately worked out in the laboratory. It seems that experiments in which an item of food is placed in an aquar-

ium containing stone crabs but no control (alternate) food items does little beyond establishing whether the crab will eat the item offered or starve. The amount of food taken would be a poor index to normal consumption.

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The Status of Seals in the Gulf of Mexico

WITH A RECORD OF FERAL OTARIID SEALS OFF

THE UNITED STATES GULF COAST

by

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ABSTRACT

The only seal native to the Gulf of Mexico and the Caribbean area is the West Indian seal (family Phocidae). It is tan on the upper surface and a yellowish white underneath. It is now extinct or nearly so. Two seals were reported in Louisiana near the mouth of the Mississippi in January 1966. Photographs of one animal taken from a helicopter showed an otariid seal. In late June a light colored otariid seal began to reside on the buoys of the ship channel leading into Mobile Bay. It stayed there about two and a half weeks. The animal was a light tan in color and was a female, with a large healing scar on the right side. It was formerly reported from buoys off Cedar Key, Florida, and a newspaper photo verified that account. The animal was similar in all respects to the California sea lion. It washed up on the beach of the Chandeleur Islands of Louisiana with a bullet hole in it and badly decomposed on 11 August 1966. On 3 April 1967 another sea lion, possibly the second Louisiana specimen, was photographed off Pensacola. Five verifiable records of the California sea lion in the Atlantic have been reported ranging from Louisiana to Newfoundland. Probably man was always involved in their transportation. The California sea lion can probably establish self-sustaining populations in the Atlantic Ocean.

INTRODUCTION

The decimation and virtual extermination of the West Indian seal *Monachus tropicalis* (Gray) has been reviewed by G. M. Allen (1942), Kellogg (1943), Moore (1953), and Gunter (1954). The last specimen was taken in 1922 (Townsend 1923) near Key West and since that time there have only been sight records on the Texas coast, one in 1932 (Gunter 1947) and one, which was reported only in an issue of a local weekly newspaper, The Rockport Pilot, printed 29 April 1957. This concerned a lone animal seen on the beach of Bolivar Peninsula east of Galveston by an "amateur naturalist," William K. Reynolds of New Jersey. Gilmore (1959) reviewed reported sightings in the Caribbean region in the early fifties. Teeth have been found from

two historic sites in South Texas, twenty miles inland from the mouth of the Nueces River and the Spanish mission "La Bahia" at Goliad (Raun 1964). These sites were also inhabited by Indians, and the teeth could have been trade items and not native to Texas, as the author pointed out.

Allen, Moore and Gunter have separately expressed hope that some remnant of the Caribbean seal, as it is also called, still survives, but several other authors have listed it as probably extinct. For that reason a report of seals in the Gulf of Mexico or the West Indies is a matter of intense interest to zoologists and conservationists.

Recent Information on Seals in the Northern Gulf

a. Louisiana

The writer was greatly intrigued by recurring reports of seals near the mouth of the Mississippi River during January 1966. The reports came from an area east of the river, now a part of one of the largest oil fields on Earth, where boat travel is extensive and there is a considerable resident population of men on anchored vessels.

The first notice came from employees of the California Company who reported two seals near the Chandeleur Islands. The account was published in the New Orleans Times-Picayune on 28 January 1966. Doubts were expressed in the same article by a public aquarium manager, who said that the "seals" were probably "nutria," which would have a poor resemblance at best. The writer was not so skeptical and immediately issued a public plea for the seals not to be harmed because they might be the nearly extinct West Indian seal. However, the next day the same paper published a picture of an animal hauled out on the Chandeleur Island beach—taken from a hovering helicopter. The picture was not very good, but it portrayed a light colored animal with the black flippers of an otariid seal showing plainly. This picture was quite disconcerting to me, because I had been looking for a phocid seal—*Monachus*—and particularly not a blond sea lion in the Gulf of Mexico superficial in appearance to *Monachus*. Be that as it may, I kept my own counsel and tried to get more information.

Parenthetically, it should be noted that the fall and winter of 1965-66 on the northern Gulf coast were salubrious and warm for the first five months and there was nothing climatic to raise doubts about sub-tropical seals in the area.

At the end of January a cold wave struck. Following that I visited the area of various anchored LSMs and LSTs, used as quarters by oil field crews, near the mouth of the River. It was not surprising that the seals were gone, but the information was elicited that two seals had been seen, that they commonly rested on top of anchor buoys of the boats, and appreciated handouts of food.

Later, California Oil Company employees stated that several seals were to be seen at the "Magnolia Tank Battery," and that I would be taken out to see them by helicopter, as soon as they stayed long enough in one place. I was in distrust of a whole herd of seals and when nothing more was heard I gave up the quest.



Plate 1. An otariid seal on a bell buoy off the mouth of Mobile Bay taken 1 July 1966.



Plate 2. Rear view of the same seal shown in Plate 1.

b. Alabama

On 1 July 1966 The Mobile Press Register showed a picture of a seal on a channel buoy just south of Sand Point Light, the lighthouse for Mobile Bay, Alabama. It was stated that this same seal had recently been seen off Cedar Key, Florida. I later learned that it was recognizable because of a scar about the right fore flipper.

Dr. William Robertson, of the Everglades National Park Staff, later furnished me with a newspaper clipping on this animal, taken from The Miami Herald, 28 April 1966. A photograph was shown with a caption stating that the animal was resting on a channel buoy twenty miles southwest of Cedar Key.

I arranged by telephone on July 1 to be conveyed to the Mobile ship channel entrance by members of the University of Alabama and the Alabama Marine Resources Laboratory at Dauphin Island. We arrived at the channel buoys at 10:30 a. m. The seal was not to be found at the inshore buoys where it had been previously seen, but by intercom a party boatman told us it was on No. 2 buoy, which lies just inside the sea buoy or outside marker. So it was, and there lay a handsome yellowish lady seal with large, lacrymating brown eyes.

This animal was sleepy and torpid and barely roused up as we cruised around the buoy to get photographs. The dark area of the fur as shown in the pictures is where the animal was wet. The lighter dry area was a very light tan or dark cream. Rear view pictures showed the distinct tail separate from the body and also showed the absence of a scrotal sack which should be visible in the male eared seals. The black hind flippers showed the prolongation of the outer phalange also characteristic of these seals, and it showed that the flippers may be turned forward and that they are not spatulate. The ears of this animal are quite visible in the photographs. The animal had a long yellow mustache with hairs all in a line and not so closely bunched together as they are in the phocid seals.

The animal had a large healing wound, lunate shaped in its upper margin, which went through the skin and the blubber and into the muscles underneath. It appeared to be granulated and healing well. At first glance one might take this as the bite of a shark, but the lower tooth marks were not discernible and possibly this wound was caused by a boat propellor.

The animal seemed to be quite tame and only roused up when we got very close, which at the closest must have been at ten to fifteen feet. It appeared to be about five feet in length. It reposed quite well on the bell buoy which was clanging loudly just over its back.

There is no doubt that the Mobile seal belonged to the family Otariidae or eared seals, and I do not have much hesitation in saying that it was a California sea lion. Dr. Robert T. Orr, of the California Academy of Sciences, concurs in that opinion after examining the photographs. Here only one photograph is shown (Plate 1).

This seal resided on the buoys off the mouth of Mobile Bay for about eighteen days and the personnel of the Seafoods Division of the Alabama Department of Conservation made an attempt to keep

up with it. Sports fishermen and charter boat operators visited the seal and fed it fish.

This seal was reported dead and badly decomposed with a bullet hole in it, washed up on the beach of the Chandeleur Islands on 11 August 1966. The discovery was made by a commercial fisherman and charter boatman who recognized the animal by its identifying scar. He gave the information to Mr. George Allen, Director of the Alabama Seafoods Division, who relayed it to me. *Sic semper innocentibus.*

Acknowledgments

I am indebted to several people at the Alabama Marine Resources Laboratory for assistance. Mr. Walter Nelson arranged for the boat trip and Messrs. Fred Reese, Alfred McNutt and John Bell, Jr., took me out. Mr. Reese took the photograph shown here. Mr. C. E. Dawson made the enlargement from the negative. I am also indebted to Dr. William B. Robertson, of the Everglades National Park, for the information from The Miami Herald.

After the above words were written Mr. Jack I. Lowe, of the U. S. Bureau of Commercial Fisheries, wrote the author in a letter dated 5 April 1967, enclosing an article and a picture of another California sea lion female on a channel buoy, the No. 6 buoy, out of Pensacola, as presented in The Pensacola News, 3 April 1967. This possibly accounts for the second animal reported by the offshore oil-field workers in Louisiana, but nothing further has been heard.

Dr. C. O. Handley, of the U. S. National Museum, told me there were reports of a "seal," presumably a California sea lion, off Norfolk, Virginia, a few years ago, circa 1964-65. Dr. H. D. Hoese, then of the University of Georgia, Sapelo Island, told me of one reported at Savannah, Georgia, three years ago. This all recalled to my mind that Mr. F. G. Wood, then of Marineland, Florida, told me of the escape of a male from Marineland, somewhere between 1938 and 1942, which made its way to Miami and lived there for several weeks under the sports fishermen docks. When a female was taken down with which to entice him back into captivity, the reverse happened and both animals lived free for several weeks until recaptured. This was all hearsay with Mr. Wood, but he and his crew captured a juvenile male California sea lion at Crescent Beach, Florida, in 1957-58. They never found out where it came from originally. It was given the name Sam and was kept at Marineland, Florida, for a time. This was confirmed in a telephone conversation with Mr. Wood on 8 December 1967. He is now Head of the Bioscience Facility of the Naval Undersea Warfare Center at Point Mugu, California.

The first published record of the California sea lion, *Zalophus californianus*, on the Atlantic coast, other than newspaper accounts, was given by Layne (1965) who reported a specimen from Florida, which he considered to be an escapee from a zoo. Mercer (1967) re-

ported the body measurements and skull measurements of an animal killed on the east coast of Newfoundland on 22 July 1965.

Summary and Conclusions

At least four California sea lions living wild and free on the Atlantic coast have been reported during the past twenty-five years. These reports are, however, not verifiable. On the other hand verifiable records, of live or dead specimens, or indubitable sight records and photographs are available for five specimens of California sea lions on the Atlantic Coast of North America, ranging from Louisiana to Newfoundland during the past ten years.

The two specimens first seen in Louisiana in January 1966 apparently account for later sightings off Cedar Keys and Pensacola, Florida, and Mobile, Alabama. Except for the Panama Canal, which is not near either one of the eastern Pacific subpopulations or subspecies of *Zalophus californianus*, there has been no recent change in geographic barriers to movement of this sea lion into the Atlantic Ocean. Therefore, the specimens found there must have been aided in their movements somehow by man.

The ability of California sea lions to live feral for months in the warm and temperate waters of the United States Atlantic Coast suggest that they could establish self-sustaining populations there.

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Effects of Predation on Infaunal Invertebrates of Alligator Harbor, Florida

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Effects of Predation On Infaunal Invertebrates Of Alligator Harbor, Florida *

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*—From a thesis submitted to the Department of Biological Sciences, Florida State University, Tallahassee, Florida, in partial fulfillment of the requirements for the degree of Master of Science.

ABSTRACT

A study of the effect of predation on infaunal invertebrates was carried out from July, 1965, to January, 1966, within the intertidal zone of Florida State University Marine Laboratory area at Alligator Harbor, located on the Northeast Gulf of Mexico. The animals were offered protection by wire-baskets of three different mesh sizes. Out of 1,112 infaunal invertebrates, 800 were recovered inside and 312 outside the baskets. The polychaetes, nemertines, phoronids, amphipods and bivalves made up the infauna; the polychaetes comprised the major part of it. Out of 34 species of polychaetes, six are reported from this area for the first time. The spawning period of two species of polychaetes and one gastropod was also observed, and the seasonal abundance of all polychaetes was noted. The depth preference of infaunal organisms was determined.

INTRODUCTION

Effect of predation on infaunal invertebrates has been a relatively neglected area of research. Practically no work has been done in the Gulf of Mexico, or for that matter in the United States in general. The only treatment available (Darnell 1958) deals with the predation of fishes, some shrimp and the blue crab, *Callinectes sapidus*, on infaunal but especially epifaunal invertebrates. Carikker (1951) observed the predation by *Busycon canaliculatum*, *B. carica*, *Urosalpinx cinerea*, *Polinices duplicata*, and *Callinectes sapidus*, on the infaunal bi-

valve, *Mercenaria mercenaria*, and epifaunal, *Modiolus demissus*, and *Crassostrea virginica*. A paper by Menzel and Nichy (1958) covered the aspects of distribution and feeding habits of some oyster predators in Alligator Harbor.

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The author is indebted to Dr. Winston Menzel, Oceanographic Institute, Florida State University, for his constant guidance and suggestions during the entire research period. Grateful acknowledgements are made to Dr. Harry W. Wells for assistance in the identification of polychaetes, and to Drs. R. B. Brown and H. M. Stevenson, for their review of the manuscript.

MATERIALS AND METHODS

Within the laboratory area six stations were established. Wire baskets were made from quarter, half, and one-inch mesh wire, each having four sides and a top, with dimensions of 34 cm x 14 cm. They were pushed into the substratum to a depth of 8 cm and set in two rows, 12 cm apart and parallel to the shore. Station 1 was located east of the laboratory pier at mean low water level. Stations 2 and 3 were parallel and 10 meters apart, the former 2.5 meters and the latter 12.5 meters from the high water level, approximately mid-intertidal and low water levels, respectively. Stations 4 and 6 were also located on mean low water level, about 55 and 45 meters, respectively, from the laboratory pier; both approximately 12.5 meters from the high water level. Station 5 was in a man-made canal, southwest of the pier and 45 meters away from it, at the intertidal level.

Fifty-four baskets of variable mesh sizes were placed at these stations but samples from only 50 were accessible to quantitative and qualitative analysis, since four baskets at Station 5 were covered with sand. Quarter-inch mesh baskets were placed at every station, half-inch mesh baskets at Station 1, and one-inch mesh baskets at Stations 1, 2 and 3.

Samples were taken by a hand-made apparatus, based on a simple vacuum device; a plexiglass cylinder, 23 cm in length and 6 cm in diameter, with a wall thickness of 2 mm and a capacity of 320 cc. To obtain the sample, it was pushed into the substratum to a depth of 22 cm and a rubber stopper was fitted in firmly; the sampler was then pulled out slowly. For one basket removed, 4 samples were taken outside of it and 4 inside. Hence, a total of 8 samples was taken for each basket, totalling 400. Enough baskets were placed initially for all the samples, and they were not replaced when removed.

Fortnightly, a quarter-inch mesh basket was removed from each station; the half-inch mesh basket from Station 1 every sixth week and one-inch mesh baskets from Stations 1, 2 and 3, after 24 weeks. The number of infaunal animals present inside and outside the baskets from each sample were counted numerically and adjusted per 1,000 cc of the substratum.

The upper and lower halves of each sample were kept separate, in order to determine the depth preference of the animals. Each

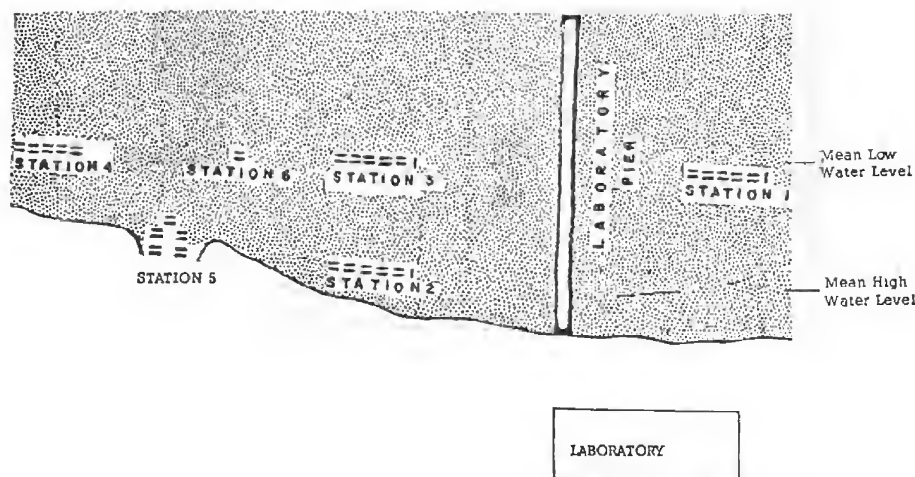


Figure 1. Arrangement of the stations at Florida State University Laboratory located at Alligator Harbor.

sample was sieved through a 2 mm-mesh wire screen to wash out the sand and mud particles. Special methods were adapted for the removal of tubicolous worms to ensure the least damage.

RESULTS AND DISCUSSION

Summary of the results is tabulated in Table 1, showing the breakdown in numbers of individuals within each infaunal species, inside and outside the baskets, occurring throughout the investigation period, as well as the depth preference and abundance of these animals.

Results obtained for the quarter-inch mesh baskets are explicit and most conclusive of all mesh sizes. At Stations 4 and 6, as many as fourfold animals were collected from inside the baskets. The former station had the largest number of infaunal invertebrates found inside and outside of any station, i.e., 408 and 111, respectively. The animal count for 1,000 cc of the substratum was 33.0 for the inside and 8.4 outside the baskets. Although a considerable increase in number of polychaetes from inside the baskets was partially a result of the juvenile stages of two polychaetes, the rest of the animals were also more numerous than outside the baskets.

The five baskets of half-inch mesh at Station 1 offered lesser protection as compared to the quarter-inch, a fact to be noted from the slight difference of inside and outside totals, i.e., 39, 31, numerically, and 6.06, 4.8 per 1,000 cc of the substratum, respectively.

One-inch mesh baskets offered no protection. The results obtained are discordant. At Station 1, the number of animals outside was greater than that inside. Very likely factors other than predation were also effective in depleting the number of infaunal organisms. A plausible reason for the low count was the retardation of free circula-

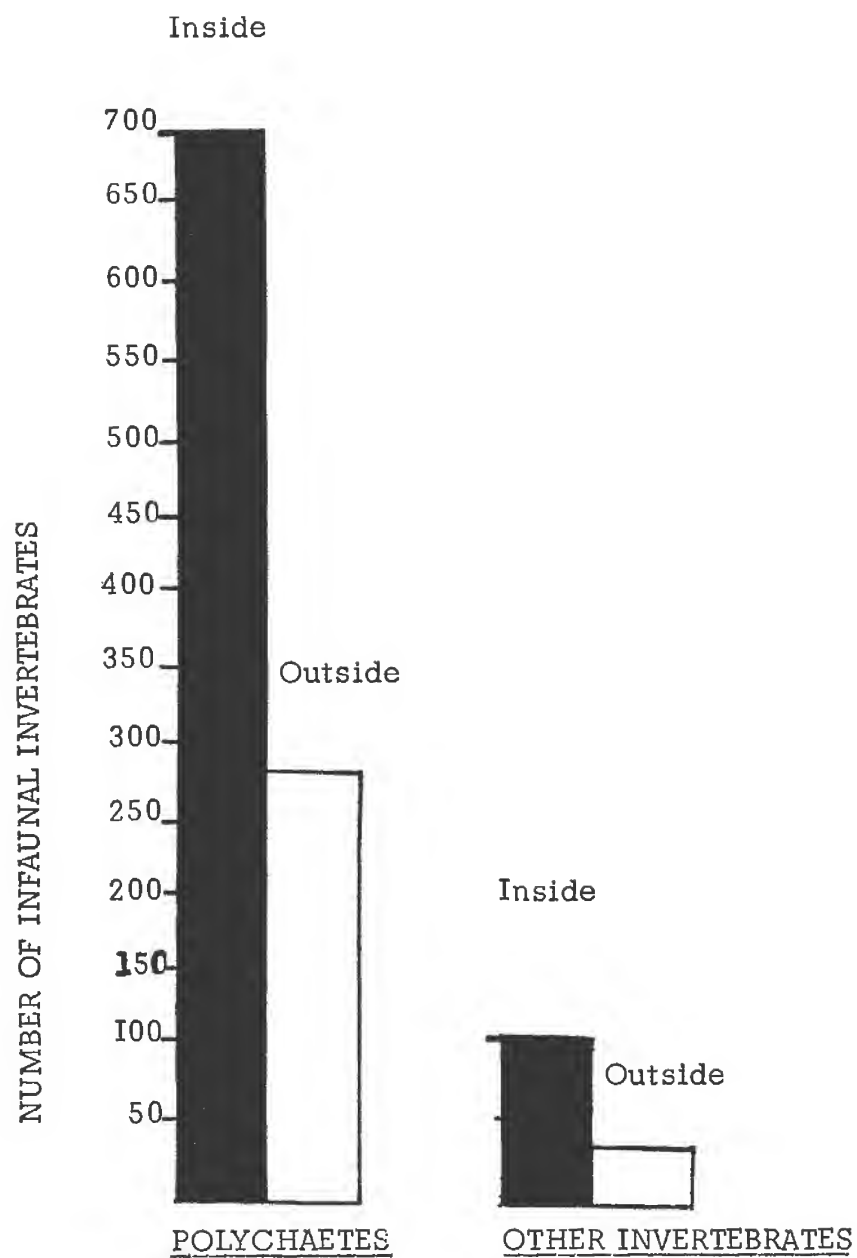


Figure 2. Distribution of polychaetes and other Infaunal Invertebrates, inside and outside the baskets.

tion of water due to a heavy infestation by colonial ascidians, *Styela plicata*, barnacles, *Cthamalus fragilis*, and bryozoans, *Bugula neritina*.

Data obtained by the individual count of animals present in upper and lower halves of the samples showed that 80% of the total were present only in upper 11 cm of the substratum, 18% occurred both in upper and lower, and only 2% exclusively from the lower-half of the samples.

Breeding periods of two species of polychaetes and a non-predatory gastropod, *Bulla striata*, were noted. The juvenile stages of the latter were found attached to the dead shells of *Terebra dislocata*, and *T. protexta*, during the month of January, 1966. Eggballs of the polychaete, *Axiiothella mucosa*, were abundant from the last week of December, 1965, through January, 1966. Their juvenile stages were recovered from samples taken during this period.

Since this work is not primarily concerned with the types of predators, species which were the most effective in limiting the infaunal population can only be suggested.

The blue crab, *Callinectes sapidus*, is very abundant at Alligator Harbor and is known to devour immature bivalves and annelid worms. Menzel and Sims (1962) planted small hard clams, *Mercenaria mercenaria*, to test the feasibility of commercial clam farming. They found that only 5% to 8% mortality took place in those clams protected by fences, while the unprotected clams had 100% mortality; 90% of them were cracked by the blue crab. Another crab, *Menippe mercenaria*, does considerable damage to bivalves and is also abundant at Alligator Harbor (Menzel and Hopkins, 1955).

Among the mollusks, the lightening whelk, *Busycon contrarium*, is a most serious enemy of the older stages of bivalves (Menzel and Nichy 1958). Carikker (1951) noticed that *Urosalpinx cinerea* drilled the shells of a bivalve, *Modiolus demissus*, and caused a high mortality. Drilled shells of *M. demissus* were often picked up in the samples; however, the extent of damage caused by the drills is not known.

Several fishes are known to feed upon bottom-dwelling crustaceans and infaunal mollusks. Only those recorded from Alligator Harbor and vicinity shall be mentioned. The sea-catfish, *Galeichthys felis*, has been noted for its selective feeding habits on worms and small crustaceans. Gunter (1945) examined 85 stomachs of this catfish which contained mud shrimp, *Callinassa jamaicensis louisianensis*, which made up about 90% food of the larger catfish. Coincidentally, it was noted that the shrimp, *Palaemonetes intermedius*, *Periclimenes longicaudatus*, and *Alpheus normanni*, were often present in very large numbers inside the baskets at every station. Protection from predation, in addition to water currents, seems to be important for these animals. Reid (1954) reported that some fish prefer to feed on amphipods and isopods, which make up the bulk of the interstitial fauna. The number of amphipods in the inside samples was always greater than outside.

Table 1. Summary of the results for infaunal invertebrates collected throughout the investigation period.

| NAME OF ANIMAL — GROUP | INSIDE SAMPLES | | | OUTSIDE SAMPLES | | | ABUND- ANCE | DEPTH Below 12 cm | PREFER- ENCE Above 12 cm |
|---|-----------------------------|-------|-------|-----------------|-------|-------|----------------|-------------------------|-----------------------------------|
| | Polychaeta | Upper | Lower | T | Upper | Lower | T | | |
| <i>Arabella iricolor</i> | | 0 | 0 | 0 | 1 | 1 | 2 | R | X |
| <i>Armandia agilis</i> | | 0 | 0 | 0 | 1 | 0 | 1 | R | X |
| <i>Axiiothella mucosa</i> | | 61 | 4 | 65 | 8 | 2 | 10 | A | X |
| <i>Branchioasychis americana</i> | | 2 | 1 | 3 | 2 | 0 | 2 | R | — |
| <i>Cirratulus grandis</i> | | 0 | 1 | 1 | 0 | 0 | 0 | R | — |
| <i>Cirriformia filigera</i> | | 25 | 20 | 45 | 23 | 3 | 26 | C | X |
| <i>Cistenides gouldii</i> | | 5 | 1 | 6 | 0 | 0 | 0 | R | X |
| <i>Diopatreia cuprea</i> | | 2 | 1 | 3 | 1 | 0 | 1 | R | X |
| <i>Dodecaceria concharum</i> | | 0 | 0 | 0 | 0 | 1 | 1 | R | — |
| <i>Dorvillea sociabilis</i> | | 1 | 0 | 1 | 0 | 0 | 0 | R | — |
| <i>Eulalia myriacyclum</i> | | 1 | 0 | 1 | 0 | 0 | 0 | R | — |
| <i>Glycera americana</i> | | 9 | 1 | 10 | 4 | 3 | 7 | C | X |
| <i>Glycera dibranchiata</i> | | 4 | 2 | 6 | 7 | 0 | 7 | C | — |
| <i>Haploscoloplos fragilis</i> | | 28 | 20 | 48 | 6 | 0 | 6 | C | X |
| <i>Heteromastus filiformis</i> | | 8 | 0 | 8 | 0 | 1 | 1 | R | X |
| <i>Loimia viridis</i> | | 1 | 0 | 1 | 0 | 0 | 0 | R | — |
| <i>Magelona californica</i> | | 16 | 40 | 56 | 30 | 12 | 42 | A | X |
| <i>Megalomma bioculatum</i> | | 2 | 0 | 2 | 0 | 0 | 0 | R | X |
| <i>Melinna maculata</i> | | 0 | 1 | 1 | 0 | 0 | 0 | R | — |
| <i>Neanthes succinea</i> | | 1 | 0 | 1 | 0 | 0 | 0 | R | X |
| <i>Nephtys bucera</i> | | 3 | 5 | 8 | 3 | 1 | 4 | C | X |
| <i>Nereiphylla fragilis</i> | | 0 | 0 | 0 | 1 | 0 | 1 | R | X |
| <i>Nereis pelagica occidentalis</i> | | 0 | 0 | 0 | 2 | 0 | 2 | R | X |
| <i>Notomastus latericeus</i> | | 9 | 11 | 20 | 3 | 2 | 5 | C | X |
| <i>Onuphis eremita</i> | | 233 | 43 | 276 | 41 | 34 | 75 | A | X |
| <i>Onuphis eremita oculata</i> | | 8 | 6 | 14 | 15 | 6 | 21 | C | X |
| <i>Owenia fusiformis</i> | | 2 | 0 | 2 | 0 | 0 | 0 | R | X |
| <i>Polydora websteri</i> | | 2 | 0 | 2 | 0 | 0 | 0 | R | X |
| <i>Prionospio</i> sp. | | 69 | 21 | 90 | 27 | 13 | 40 | A | X |
| <i>Pista palmata</i> | | 1 | 0 | 1 | 0 | 0 | 0 | R | — |
| <i>Poecilochaetous johnsoni</i> | | 0 | 1 | 1 | 0 | 3 | 3 | R | — |
| <i>Scoloplos rubra</i> | | 12 | 17 | 29 | 13 | 6 | 19 | A | X |
| <i>Stylarioides inflata</i> | | 1 | 0 | 1 | 0 | 0 | 0 | R | — |
| <i>Synsyllis longigularis</i> | | 1 | 1 | 2 | 0 | 0 | 0 | R | X |
| <i>Brachiodontes exutus</i> Bivalvia | | 4 | 4 | 8 | 1 | 0 | 1 | R | X |
| <i>Brachiodontes recurvus</i> Bivalvia | | 2 | 0 | 2 | 2 | 0 | 2 | R | — |
| <i>Dosinia elegans</i> Bivalvia | | 5 | 0 | 5 | 0 | 0 | 0 | C | X |
| <i>Nuculana acuta</i> Bivalvia | | 4 | 0 | 4 | 2 | 0 | 2 | R | — |
| <i>Parastarte triquetra</i> Bivalvia | | 2 | 6 | 8 | 0 | 0 | 0 | C | X |
| <i>Tagelus divisus</i> Bivalvia | | 1 | 1 | 2 | 0 | 0 | 0 | R | X |
| <i>Tellina versicolor</i> Bivalvia | | 2 | 0 | 2 | 0 | 0 | 0 | R | X |
| <i>Mitrella lunata</i> Gastropoda | | 12 | 0 | 12 | 2 | 0 | 2 | C | X |
| <i>Ampelisca macrocephala</i> Amphipoda | — Not counted in the totals | | | | | | | | |
| <i>Melita fresneli</i> Amphipoda | — Not Counted in the totals | | | | | | | | |
| <i>Phoronis architecta</i> Phoronida | | 9 | 27 | 36 | 13 | 12 | 25 | A | X |
| <i>Cerebratulus lacteus</i> Nemertea | | 0 | 7 | 7 | 0 | 0 | 0 | R | X |
| <i>Lineus socialis</i> Nemertea | | 4 | 6 | 10 | 2 | 2 | 4 | C | X |
| <i>Tubulanus</i> sp. Nemertea | — Not Counted in the totals | | | | | | | | |
| TOTAL NUMBER OF ANIMALS | | | | 800 | 312 | | | | |
| NUMBER OF ANIMALS PER 1000 cc. | | | | 12.5 | 4.6 | | | | |

OBSERVATIONS

The seasonal abundance of polychaetes was observed during the entire investigation period. On the basis of individual count of each species, they fall into two main categories. The first were common during December and January, and the second occurred in equal abundance throughout. The majority of species followed the latter pattern. Those most abundant during December and January were: *Axiothella mucosa*, *Prionospio* sp., *Magelona californica*, *Cirriformia filigera*, and *Haploscolopos fragilis*.

The following species of polychaetes are reported from this area for the first time:

Cirriformia filigera delle Chiaje is one of the most common species found here (Table 1). Hartman (1951) recorded this species from Lemon Bay, Sarasota County, Florida, and Englewood, Florida. It is also known from both sides of the North Atlantic Ocean and south to Brazil. Only few specimens of a cirratulid, *Cirratulus grandis* Verrill, were found at this region. However, it is very common along the entire coast of New England. *Dorvillea sociabilis* Webster is also a rare species, found with an ascidian, probably as a commensal. Two specimens of *Megalomma bioculatum* Ehlers were collected in the samples. This species was originally recorded by Ehlers (1887) off Florida. *Poecilochaetus johnsoni* Claparede is uncommon. Other species of this genus have been reported from the Atlantic coast of Ireland and Norway. The last species, *Stylarioides inflata* Hartman, is more widely distributed on the Pacific side of North America, from Oregon to Lower California. It has also been recorded from Lemon Bay, Sarasota County, Florida (Hartman 1951).

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Meristic and Morphometric Data on the Flatfish

Citharichthys gilberti from Panama

by

C. E. Dawson

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Citharichthys gilberti Jenkins and Evermann, a common eastern Pacific flatfish, is known from Guaymas and Baja California, Mexico, south to Peru (Miller, 1966). It attains a total length of at least 260 mm (Meek and Hildebrand, 1928), frequently occurs on muddy bottoms and may enter rivers or other brackish water environments. Despite wide distribution there are apparently few literature references to the species and little is known of its life history or development. During a recent trip to the Pacific coast of Panama, *C. gilberti* was found to be the most abundant flatfish taken at a number of poisoned inshore and intertidal stations. Sufficient specimens were obtained over a broad size range, 18-193 mm SL, to permit the present report on meristic and morphometric characteristics of the isthmian population.

Counts and measurements made on undamaged freshly preserved material generally follow the methods of Norman (1934) with these exceptions or additions: standard length is measured from the anterior extremity to the rear of the hypural; pelvic fin length from the outer axillary angle to the tip of the longest ray; pectoral length from the upper (right) axillary angle to the tip of the longest ray; postorbital length from posterior margin of the right orbit to the extremity of the bony opercle; the last two dorsal and anal fin rays are counted separately. Vertebral counts are from radiographs.

Lateral line scales ranged from 41 to 45 and the count averaged 42.7 in 66 specimens. Data on other counts and measurements are shown in Tables 1 through 5.

With the exception of eye diameter, postorbital and maxillary lengths (Fig.1), proportional measurements generally indicate isometric growth over the present size range. Eye diameter is negatively allometric and ranges from over 27 per cent of head length at 20 mm SL to less than 15 per cent at 190 mm. Postorbital and maxillary lengths are positively allometric over the same size range.

Meek and Hildebrand (*op. cit.*) doubtfully referred two larvae, 25 and 40 mm TL, to *C. gilberti*. Present collections include fifteen specimens 18.2-31.8 mm SL (23.2-40.2 mm TL) wherein eye migration is complete and coloration and other characteristics agree with those

Table 1. Range, mean, standard deviation and standard error for 11 characters in *Citharichthys gilberti* (18.2-192.9 mm SL) shown in per cent of standard length or head length.

| Character | N | Per Cent of Standard Length or Head Length | | | |
|---------------------------|----|---|------|----------|-------|
| | | Range | Mean | σ | Sx |
| Caudal fin length | 84 | 21.3-30.1 | 24.0 | 1.664 | 0.182 |
| Body depth | 87 | 39.3-50.7 | 45.0 | 2.814 | 0.302 |
| Left pectoral fin length | 86 | 11.3-16.6 | 13.7 | 1.067 | 0.115 |
| Right pectoral fin length | 83 | 8.5-14.1 | 10.8 | 1.058 | 0.116 |
| Left pelvic fin length | 83 | 7.7-12.3 | 10.0 | 0.771 | 0.085 |
| Right pelvic fin length | 80 | 8.5-14.3 | 11.2 | 1.144 | 0.128 |
| Head length | 87 | 26.0-32.1 | 28.3 | 1.470 | 0.158 |
| Eye diameter* | 87 | 14.0-23.6 | 20.5 | 3.841 | 0.412 |
| Snout length* | 86 | 18.4-23.6 | 20.8 | 1.330 | 0.143 |
| Postorbital length* | 86 | 56.1-69.1 | 63.9 | 2.574 | 0.278 |
| Maxillary length* | 81 | 36.5-43.4 | 39.9 | 1.552 | 0.172 |

*—In per cent of head length.

Table 2. Frequency distribution of dorsal and anal fin rays in *Citharichthys gilberti*. Mean of dorsals = 83.6; σ = 2.284; Sx = 0.275; mean of anals = 62.7; σ = 1.953; Sx = 0.235.

| Anal Fin Rays | Dorsal Fin Rays | | | | | | | | | | | Totals |
|---------------------|-----------------|----|----|----|----|----|----|----|----|----|----|--------|
| | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | |
| 59 | 1 | 1 | | | | | | | | | | 2 |
| 60 | | 3 | 1 | 1 | 1 | | | | | | | 6 |
| 61 | | 3 | 5 | | 4 | 1 | | | | | | 13 |
| 62 | | | 1 | 3 | 6 | 3 | | 1 | | | | 14 |
| 63 | | | | 1 | 2 | 2 | 4 | | | | | 9 |
| 64 | | | | | | 4 | 4 | 3 | 1 | | | 12 |
| 65 | | | | | | | 2 | 1 | 1 | | | 4 |
| 66 | | | | | | | 1 | 3 | 2 | 1 | 1 | 8 |
| 67 | | | | | | | | | | 1 | | 1 |
| Tot- als | 1 | 7 | 7 | 5 | 13 | 10 | 11 | 8 | 4 | 2 | 1 | 69 |

Table 3. Frequency distribution of right and left pectoral fin rays in *Citharichthys gilberti*.

| Right Pectoral Rays | Left Pectoral Rays | | | | | Totals |
|---------------------|--------------------|---|----|----|----|--------|
| | 8 | 9 | 10 | 11 | 12 | |
| 8 | | | | 1 | | 1 |
| 9 | | | 31 | 6 | | 37 |
| 10 | | 1 | 2 | 26 | 1 | 30 |
| Totals | | 1 | 33 | 33 | 1 | 68 |

Table 4. Frequency distribution of gill rakers on the upper and lower limbs of the first gill arch in *Citharichthys gilberti*.

| Upper Arch | Lower Arch | | | | | Totals |
|------------|------------|----|----|----|----|--------|
| | 12 | 13 | 14 | 15 | 16 | |
| 3 | 1 | | | | | 1 |
| 4 | 1 | 14 | 7 | 4 | | 26 |
| 5 | 2 | 11 | 14 | 2 | 1 | 30 |
| 6 | | | | | | |
| Totals | 4 | 25 | 21 | 6 | 1 | 57 |

Table 5. Frequency distribution of precaudal and caudal vertebrae in *Citharichthys gilberti*.

| Precaudal Vertebrae | Caudal Vertebrae | | | Totals |
|---------------------|------------------|----|----|--------|
| | 23 | 24 | 25 | |
| 9 | | | 3 | 3 |
| 10 | 3 | 63 | 4 | 70 |
| 11 | | 1 | | 1 |
| Totals | 3 | 64 | 7 | 74 |

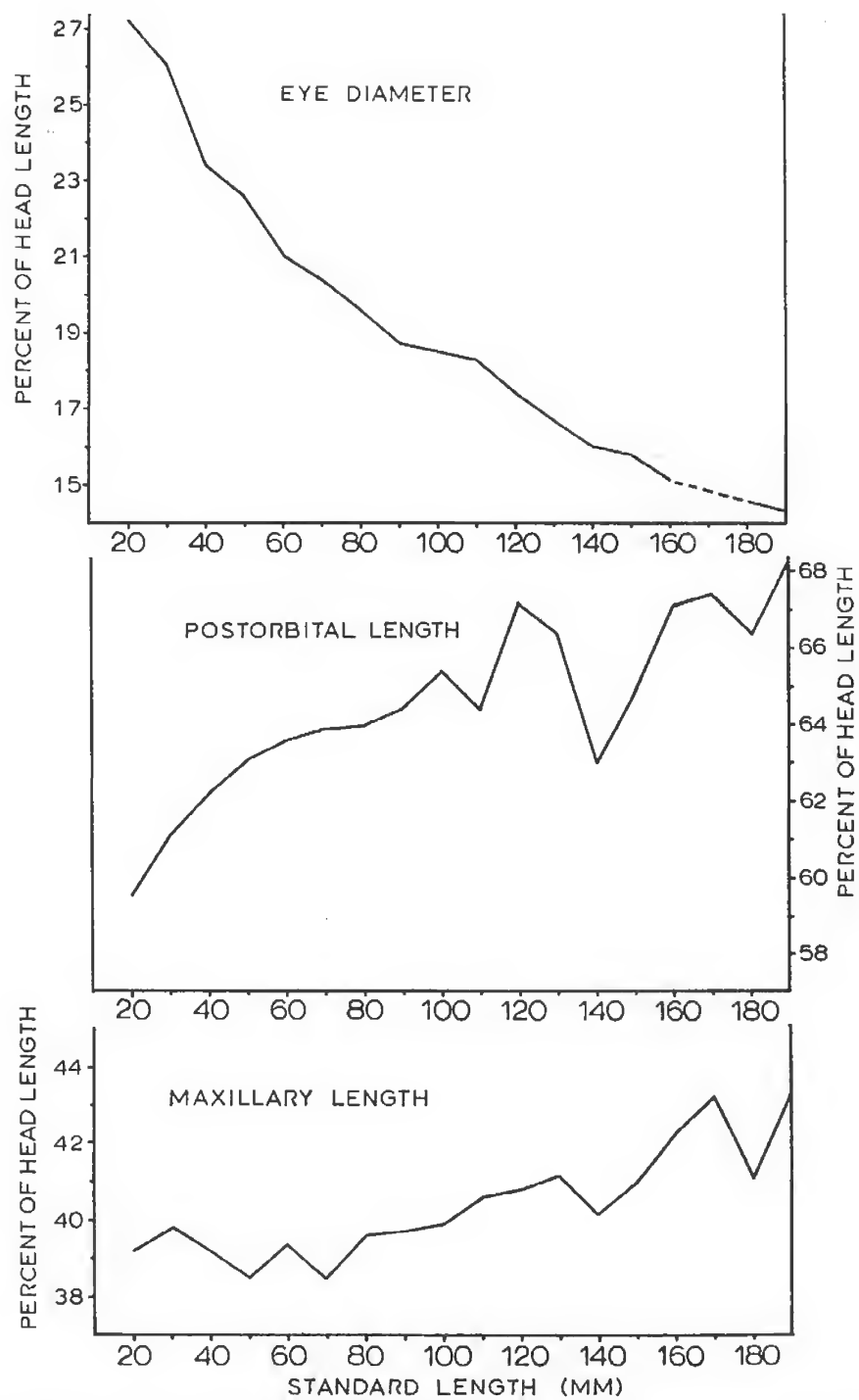


Figure 1. Proportional measurements of three characters in *Citharichthys gilberti* shown in per cent of head length. Data have been averaged for 10 mm SL intervals.

of the adult. It would appear that larval specimens of Meek and Hildebrand represent some flatfish other than *C. gilberti*.

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